DEVELOPMENT OF THE TTS WOOD "I" FLOOR AND ROOF JOIST SYSTEM

with funding provided by

Alberta
DEPARTMENT OF HOUSING
Innovative Housing Grants Program

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Prepared By:

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The views and conclusions expressed and the recommendations made in this report are entirely those of the authors and should not be construed as expressing the opinions of the Alberta Department of Housing.

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FOREWORD

This study was made possible with funding provided by the Innovative Housing Grants Program of the Alberta Department of Housing. Originally conceived in 1978, the Program is intended to encourage, sponsor, and assist research and development in the fields of housing, site and subdivision design, energy conservation, site servicing and building product development. Generally, the aims of research funded by the Innovative Housing Grants Program are to reduce housing costs, increase the supply of appropriate housing or improve the utility or performance of dwelling units or subdivisions.

The main purpose of funding these studies is to examine the current issues in the field of housing and to develop innovations which offer improvements. Comments and suggestions regarding the information contained in these reports are welcome.

Innovative ideas come from a wide variety of applicants such as builders, developers, consulting firms, industry associations, municipal governments, educational institutions, non-profit groups and individuals. As the type of project and level of resources vary from applicant to applicant, the resulting documents are also varied.

Please send comments and suggestions or requests for further information to:

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1.0 INTRODUCTION

Due to the rapidly decreasing supply of large dimensional lumber in Western Canada and the anticipated price increases for large dimensional lumber in the longer term, a substantial effort is being made by some in the forest products industry to develop alternatives for the conventional wood floor joists used widely in North America.

This report describes some of the development aspects of a composite Wood "I" floor and roof joist called the TTS Wood "I". This Wood "I" consists of a wafer board web and 38 mm (1 1/2") deep top and bottom chord which are 64 mm (2 1/2") or 89 mm (3 1/2") wide. The web and chords are pressure glued in a pinch-roll assembly utilizing a patented joint. The Wood "I" is available in depths of up to 600 mm (24") and lengths of up to 15 m (50' - 0").

In order to receive acceptance for use in housing projects insured under the National Housing Act, Canada Mortgage and Housing Corporation carried out an evaluation of the Wood "I". The Building Standards Branch of Alberta Labour assessed the fire resistance rating of an unrestrained floor/ceiling assembly. The Underwriters' Laboratories of Canada carried out a one hour fire test on a Wood "I" floor/ceiling assembly.

Chapter 2 describes the Wood "I", lists the advantages and gives span tables for the various depths of the Wood "I" as well as loading conditions. Regulatory testing, evaluation, and acceptance are discussed in Chapter 3. A summary and conclusions are provided in Chapter 4.

2.0 TTS WOOD "I" DESCRIPTION

2.1 Introduction

The TTS Wood "I" is an "I" section wood beam fabricated with machine stress rated or visually graded sawn lumber chords and a graded wafer board* web (see figure, p. 5). The continuous chords are 38 mm deep and are either 64 mm or 89 mm wide. The webs are either 9.5 mm thick wafer board for joists up to 450 mm deep, or 15.9 mm thick wafer board for joist depths up to 600 mm. Two 3 mm wide by 12.7 mm deep saw kerfs are cut into the wide face of each chord and these kerfs are splayed five degrees from the vertical. A 12.7 mm saw kerf is cut into each edge of the wafer board to allow for a tongue-and-groove mating with the chords. The web and chords are pressure glued in a pinch-roll assembly.

No chord slicing is done for joist lengths 6096 mm (20') or less whereas for joists longer than 6096 mm, the chords are finger jointed and are supplied from a CSA certified mill. The wafer board web sections are installed in 4877 mm (16'), 2438 mm (8') and 1219 mm (4') lengths. The web butt joints are strategically placed near the center of the joists where the shear stresses are minimal, and they are not glued or spliced. The webs may have 50 mm (2") diameter round holes spaced a minimum distance of 600 mm (24") on center to accommodate services. The holes are located along the center line of the web with the center line of the holes nearest to the joint ends not closer than 914 mm (3') to the end of the joist.

2.2 Selection of Materials

The choice of standard dimension lumber for the top and bottom chords was made on the basis of its ready availability, low cost and easy fabrication.

*Due to its superior strength and better tolerance, oriented strand board (o.s.b.) is now used for the web material.

Plywood and wafer board were both considered as web material. Wafer board was selected for the following reasons:

a) wafer board can be supplied in greater lengths than plywood, meaning that for most spans the web materials would not have to be spliced;
b) wafer board has higher shear resistance than plywood, an advantage; and
c) wafer board is less costly than plywood.

2.3 Advantages of the TTS Wood "I"

The Wood "I" has the following advantages:

a) Large clear spans eliminate the need for built-up beams, allowing greater flexibility of plan layout and future development.

b) Its use results in a stiffer floor system - less bounce and squeak.

c) Often, no dropped ceilings required, as electrical, plumbing and ducting can all be concealed within the floor system, therefore allowing greater flexibility in design.

d) On site modifications are simple, eg. cutting to exact required length, which are not possible without costly repairs on typical trussed joist systems.

e) They are easily adaptable to a wide variety of bearing and floor opening situations.

f) They provide wider nailing and glueing surfaces for subfloor and ceiling finishes.

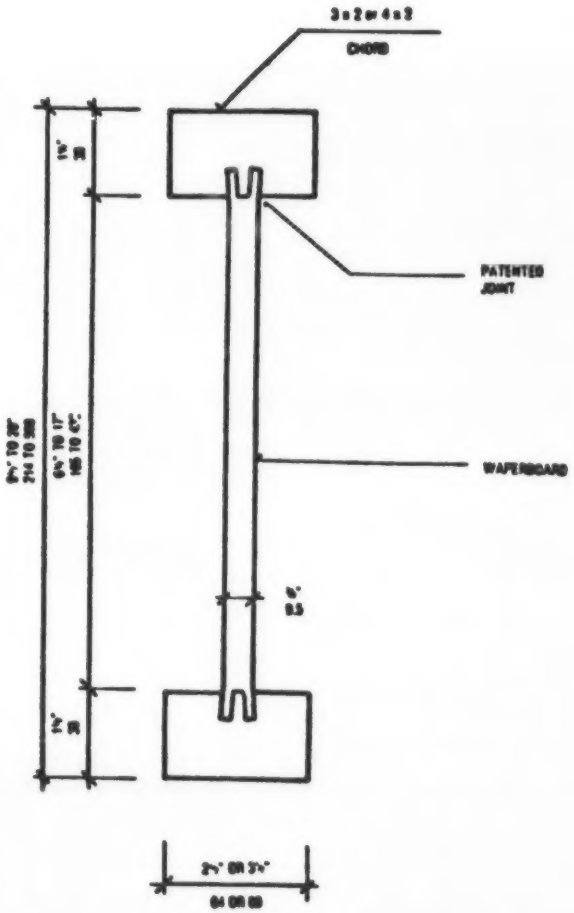
g) They undergo less shrinkage than conventional dimensional lumber joists.

h) They are more dimensionally uniform than dimensional lumber.

i) They offer the potential for reduced installation labour costs.

2.4 Span Tables

Span tables for different live loading conditions have been developed for the Wood "I" and are shown on page 6 to page 17 inclusive.



TTS WOOD I by Jager Industries Inc., Calgary, Alberta

Product Description
The Wood I joist is an "I" section beam fabricated with machine stress rated or visually graded sawn lumber chords and a graduated waferboard web. All chords are 38mm deep and may be 64mm or 89mm wide. The web is made from 9.5mm thick waferboard for joists up to 508mm deep and 15.9mm thick for joist depths up to 600mm. Two, 3mm wide, 12.7mm deep, saw kerfs are cut into the wide face of each chord and these kerfs are splayed five degrees from the vertical. A 12.7mm saw kerf is cut into each edge of the waferboard to allow for a tongue and groove mating with the chords. The web and flanges are pressure glued in a pinch roll assembly. All web joints are butt joints and no web joint is to occur within 600mm of the beam ends, interior supports or chord splices. Various methods of chord splicing may be incorporated as indicated by approved details.

HANDLING and Installation Notes
1. Do not cut, drill or notch the top or bottom chord unless specified in an approved detail.
2. Small holes may be cut into the web to allow passage of plumbing, wiring and conduit. For specific information on holes larger than 38mm diameter see approved details.
3. Wood I components should be protected from moisture at all times.
4. Wood I components must be handled carefully to prevent damage during shipping, storage, installation and application.
5. All fastenings, resistance to uplift or any member not specifically detailed are subject to local approval.
6. Compression chords are to be fully laterally restrained.
7. Wood I will not support workmen or other loads until properly installed and restrained.
8. Web stiffeners may be required to achieve full structural performance. See approved detail.

TTS

ROOF ..... ☐	LOADING
FLOOR ..... ☐	..... LIVE
SPACING	..... DEAD
..... OC	..... TOTAL
CHECKED BY	CODES
	CSA/C ..... ☐
	NBC 88 Part 9 ☐
	NBC 85 Part 4 ☐
DATE & REVISIONS	DRWG NO

DESIGN CRITERIA

ALL CHARTS CONFORM TO:

- The National Building Code of Canada, latest edition.
- CAN 3-086-M80 "Code for Engineering Design in Wood".

ALL CHARTS BASED ON:

- dry service condition
- untreated lumber
- load sharing for spacings up to 600mm (24"); stress increase factor 1.1*
- full lateral restraint of top chord by plywood decking or an acceptable substitute
- clear span

ROOF CHARTS ARE BASED ON:

- uniformly distributed load
- two month load duration (115% allowable stress)

FLOOR CHARTS ARE BASED ON:

- normal load duration (100% allowable stress)

* **IMPORTANT NOTE: Charts cannot be used for TTS Wood "I" spacing exceeding 600mm (24") on centers.**

SPECIFYING THE TTS WOOD "I"

Floor charts that will be used most often in this manual are done as span tables. All other charts are done as load/span tables in both N/m and PLF.

To read the span charts, simply read across for spacing and down for span, making sure to be looking under the right heading for chord size and depth.

To read the load/span charts read down for span and across for N/m (PLF) strength.

To be able to use the charts calculate first:

(a) Total Load in kN/m^2 x Spacing in mm = N/m

(b) Total Load in PSF x Spacing in ft. = PLF

FLOOR JOIST SPAN CHARTS

89 x 38, 4 x 2 CHORDS

BASED ON 1.92 kN/m², 40 PSF LIVE LOAD .5 kN/m², 10 PSF DEAD LOAD
DEFLECTION OF L/360 LIVE LOAD

DIMENSION BASED ON CLEAR SPAN

SPECIES	DEPTH	SPACING mm/in			
	mm	300	400	480	600
	in	12	16	19.2	24
	241	6045	5232	4775	4267
	9½	19'10"	17'2"	15'8"	14'0"
	292	6858	5944	5410	4851
	11½	22'6"	19'6"	17'9"	15'11"
SPF #1	317	7239	6248	5715	5105
	12½	23'9"	20'6"	18'9"	16'9"
	406	8407	7290	6655	5944
	16	27'7"	23'11"	21'10"	19'6"
	457	9017	7823	7137	6375
	18	29'7"	25'8"	23'5"	20'11"
	508	9601	8306	7595	6782
	20	31'6"	27'3"	24'11"	22'3"
	241	6223	5639	5309	4928
	9½	20'5"	18'6"	17'5"	16'2"
	292	7214	6553	6172	5715
	11½	23'8"	21'6"	20'3"	18'9"
	317	7696	6985	6579	6096
SPF SS	12½	25'3"	22'11"	21'7"	20'0"
	406	9296	8433	7925	7290
	16	30'6"	27'8"	26'0"	23'11"
	457	10135	9195	8661	7823
	18	33'3"	30'2"	28'5"	25'8"
	508	10973	9957	9296	8331
	20	36'0"	32'8"	30'6"	27'4"
	241	6832	6223	5842	5410
	9½	22'5"	20'5"	19'2"	17'9"
	292	7950	7214	6782	6299
	11½	26'1"	23'8"	22'3"	20'8"
MSR	317	8458	7696	7239	6706
2100f · 1.8E	12½	27'9"	25'3"	23'9"	22'0"
	406	10211	9245	8712	8077
	16	33'6"	30'4"	28'7"	26'6"
	457	11125	10109	9500	8814
	18	36'6"	33'2"	31'2"	28'11"
	508	12040	10922	10262	9525
	20	39'6"	35'10"	33'8"	31'3"

FLOOR PERFORMANCE CONSIDERATIONS:

The spans indicated in the above chart meet or exceed N.B.C.C. requirements and will provide acceptable performance for the user. However safely supporting the loads to be imposed is not always the only consideration. The sensitivity of the occupant to the "feel" of the floor system must be taken into consideration. Please consult FLOOR PERFORMANCE CONSIDERATIONS on page 20.

FLOOR JOIST SPAN CHARTS

89 x 38, 4 x 2 CHORDS

BASED ON 1.92 kN/m², 40 PSF LIVE LOAD .72 kN/m², 15 PSF DEAD LOAD
DEFLECTION OF L/360 LIVE LOAD

DIMENSION BASED ON CLEAR SPAN

SPECIES	DEPTH	SPACING mm/in			
	mm	300	400	480	600
	in	12	16	19.2	24
SPF #1	241	5766	5004	4547	4089
	9½	18'11"	16'5"	14'11"	13'5"
	292	6528	5664	5156	4662
	11½	21'5"	18'7"	16'11"	15'2"
	317	6883	5969	5461	4877
	12½	22'7"	19'7"	17'11"	16'0"
	406	8026	6934	6350	5664
	16	26'4"	22'9"	20'10"	18'7"
	457	8611	7442	6807	6071
	18	28'3"	24'5"	22'4"	19'11"
	508	9144	7925	7239	6477
	20	30'0"	26'0"	23'9"	21'3"
SPF SS	241	6223	5639	5309	4928
	9½	20'5"	18'6"	17'5"	16'2"
	292	7214	6553	6172	5664
	11½	23'8"	21'6"	20'3"	18'7"
	317	7696	6985	6579	5994
	12½	25'3"	22'11"	21'7"	19'8"
	406	9296	8433	7772	6960
	16	30'6"	27'8"	25'6"	22'10"
	457	10135	9144	8357	7468
	18	33'3"	30'0"	27'5"	24'6"
	508	10973	9728	8865	7950
	20	36'0"	31'11"	29'1"	26'1"
MSR 2100f - 1.8E	241	6833	6223	5482	5055
	9½	22'5"	20'5"	19'2"	16'7"
	292	7950	7214	6782	6274
	11½	26'1"	23'8"	22'3"	20'7"
	317	8458	7696	7239	6706
	12½	27'9"	25'3"	23'9"	22'0"
	406	10211	9245	8712	8077
	16	33'6"	30'4"	28'7"	26'6"
	457	11125	10109	9500	8814
	18	36'6"	33'2"	31'2"	28'11"
	508	12040	10922	10262	9373
	20	39'6"	35'10"	33'8"	30'9"

FLOOR PERFORMANCE CONSIDERATIONS:
The spans indicated in the above chart meet or exceed N.B.C.C. requirements and will provide acceptable performance for the user. However safely supporting the loads to be imposed is not always the only consideration. The sensitivity of the occupant to the "feel" of the floor system must be taken into consideration. Please consult FLOOR PERFORMANCE CONSIDERATIONS on page 20.

FLOOR JOIST SPAN CHARTS

89 x 38, 4 x 2 CHORDS

BASED ON 1.92 kN/m², 40 PSF LIVE LOAD, 1.0 kN/m², 20 PSF DEAD LOAD
DEFLECTION OF L/360 LIVE LOAD OR 13 mm (½"), WHICHEVER IS LESS

DIMENSION BASED ON CLEAR SPAN

SPECIES	DEPTH	SPACING mm/in			
	mm	300	400	480	600
	in	12	16	19.2	24
SPF #1	241	5512	4775	4369	3912
	9½	18'1"	15'8"	14'4"	12'10"
	292	6248	5410	4953	4420
	11½	20'6"	17'9"	16'3"	14'6"
	317	6604	5715	5207	4653
	12½	21'8"	18'9"	17'1"	15'4"
	406	7670	6655	6070	5435
	16	25'2"	21'10"	19'11"	17'10"
	457	8230	7137	6502	5817
	18	27'0"	23'5"	21'4"	19'1"
	508	8763	7595	6934	6198
	20	28'9"	24'11"	22'9"	20'4"
SPF SS	241	5766	5359	5105	4674
	9½	18'11"	17'7"	16'9"	15'4"
	292	6426	5994	5715	5410
	11½	21'1"	19'8"	18'9"	17'9"
	317	6756	6274	5995	5664
	12½	22'2"	20'7"	19'8"	18'7"
	406	7772	7214	6883	6528
	16	25'6"	23'8"	22'7"	21'5"
	457	8306	7722	7366	6960
	18	27'3"	25'4"	24'2"	22'10"
	508	8788	8179	7798	7366
	20	28'10"	26'10"	25'7"	24'2"
MSR 2100f · 1.8E	241	6172	5740	5486	4674
	9½	20'3"	18'10"	18'0"	15'4"
	292	6909	6426	6147	5791
	11½	22'8"	21'1"	20'2"	19'0"
	317	7239	6731	6426	6096
	12½	23'9"	22'1"	21'1"	20'0"
	406	8331	7747	7391	6985
	16	27'4"	25'5"	24'3"	22'11"
	457	8890	8280	7899	7468
	18	29'2"	27'2"	25'11"	24'6"
	508	9423	8763	8382	7925
	20	30'11"	28'9"	27'6"	26'0"

FLOOR PERFORMANCE CONSIDERATIONS:
The spans indicated in the above chart meet or exceed N.B.C.C. requirements and will provide acceptable performance for the user. However safely supporting the loads to be imposed is not always the only consideration. The sensitivity of the occupant to the "feel" of the floor system must be taken into consideration. Please consult FLOOR PERFORMANCE CONSIDERATIONS on page 20.

FLOOR JOIST SPAN CHARTS

89 x 38, 4 x 2 CHORDS

BASED ON 1.92 kN/m², 40 PSF LIVE LOAD, 1.03 kN/m², 21.5 PSF DEAD LOAD
DEFLECTION OF L/360 LIVE LOAD

DIMENSION BASED ON CLEAR SPAN

SPECIES	DEPTH	SPACING mm/in			
	mm	300	400	480	600
	in	12	16	19.2	24
SPF #1	241	5461	4724	4318	3861
	9½	17'11"	15'6"	14'2"	12'8"
	292	6172	5359	4877	4369
	11½	20'3"	17'7"	16'0"	14'4"
	317	6528	5639	5156	4597
	12½	21'5"	18'6"	16'11"	15'1"
	406	7595	6579	5994	5359
	16	24'11"	21'7"	19'8"	17'7"
	457	8128	7036	6426	5740
	18	26'8"	23'1"	21'1"	18'10"
	508	8661	7493	6833	6121
	20	28'5"	24'7"	22'5"	20'1"
SPF SS	241	6223	5639	5283	4572
	9½	20'5"	18'6"	17'4"	15'0"
	292	7214	6553	5994	5359
	11½	23'8"	21'6"	19'8"	17'7"
	317	7696	6934	6325	5664
	12½	25'3"	22'9"	20'9"	18'7"
	406	9296	8052	7366	6579
	16	30'6"	26'5"	24'2"	21'7"
	457	9982	8636	7899	7061
	18	32'9"	28'4"	25'11"	23'2"
	508	10617	9195	8382	7518
	20	34'10"	30'2"	27'6"	24'8"
MSR 2100f - 1.8E	241	6833	6223	5613	4572
	9½	22'5"	20'5"	18'5"	15'0"
	292	7950	7214	6782	5664
	11½	26'1"	23'8"	22'3"	18'7"
	317	8458	7696	7239	6223
	12½	27'9"	25'3"	23'9"	20'5"
	406	10211	9246	8687	7772
	16	33'6"	30'4"	28'6"	25'6"
	457	11125	10109	9322	8331
	18	36'6"	33'2"	30'7"	27'4"
	508	12040	10846	9906	8865
	20	39'6"	35'7"	32'6"	29'1"

FLOOR PERFORMANCE CONSIDERATIONS:
The spans indicated in the above chart meet or exceed N.B.C.C. requirements and will provide acceptable performance for the user. However safely supporting the loads to be imposed is not always the only consideration. The sensitivity of the occupant to the "feel" of the floor system must be taken into consideration. Please consult FLOOR PERFORMANCE CONSIDERATIONS on page 20.

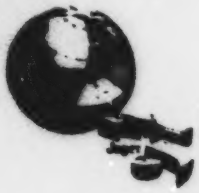
FLOOR LOAD TABLES

64 x 38, 3 x 2 CHORDS

CLEAR SPAN	LIVE LOAD LIMIT Note 1		LIVE LOAD LIMIT Note 2	
	241 9½" Deep	292 11½" Deep	241 9½" Deep	292 11½" Deep
	SPF #1	SPF #1	SPF #1	SPF #1
3050	2174	2802	2174	2802
10'0"	149	192	149	192
3353	1795	2306	1795	2306
11'0"	123	158	123	158
3660	1518	1941	1518	1941
12'0	104	133	104	133
3962	1284	1649	1284	1649
13'0"	88	113	88	113
4267	1109	1430	1109	1430
14'0"	76	98	76	98
4572	963	1240	963	1240
15'0"	66	85	66	85
4877	846	1095	846	1095
16'0"	58	75	58	75
5182	759	963	759	963
17'0"	52	66	52	66
5486		861		861
18'0"		59		59
5791		773		773
19'0"		53		53

IMPORTANT NOTES:

1. Based on floor live load deflection of L/360.
2. Based on CMHC criteria; live load deflection of L/360 or 13 mm, (½") whichever is less.
3. Metric loading capacity in N/m.
4. Imperial loading capacity in PLF.
5. Table designed with assumption that live load does not exceed 70% of total load.



FLOOR LOAD TABLES

89 x 38, 4 x 2 CHORDS

241, 9½" DEEP

CLEAR SPAN	LIVE LOAD LIMIT Note 1			LIVE LOAD LIMIT Note 2		
	SPF 1 & 2	SPF SS	2100	SPF 1 & 2	SPF SS	2100
3050	2860	2860	2860	2860	2860	2860
10'0"	**196**	**196**	**196**	**196**	**196**	**196**
3353	2379	2554	2554	2379	2554	2554
11'0"	**163**	**175**	**175**	**163**	**175**	**175**
3660	1999	2306	2306	1999	2306	2306
12'0"	**137**	**158**	**158**	**137**	**158**	**158**
3962	1693	2102	2102	1693	2102	2102
13'0"	**116**	**144**	**144**	**116**	**144**	**144**
4267	1459	1941	1941	1459	1941	1941
14'0"	**100**	**133**	**133**	**100**	**133**	**133**
4572	1270	1795	1795	1270	1795	1795
15'0"	**87**	**123**	**123**	**87**	**123**	**123**
4877	1124	1664	1664	1124	1664	1664
16'0"	**77**	**114**	**114**	**77**	**114**	**114**
5182	992	1503	1562	992	1313	1562
17'0"	**68**	**103**	**107**	**68**	**90**	**107**
5486	890	1270	1459	890	1051	1401
18'0"	**61**	**87**	**100**	**61**	**72**	**96**
5791	803	1065	1386	773	846	1124
19'0"	**55**	**73**	**95**	**53**	**58**	**77**
6096		919	1226			919
20'0"		**63**	**84**			**63**
6400			1065			
21'0"			**73**			

IMPORTANT NOTES:

1. Based on floor live load deflection of L/360.
2. Based on CMHC criteria; live load deflection of L/360 or 13 mm, (½") whichever is less.
3. Metric loading capacity in N/m.
4. Imperial loading capacity in PLF.
5. Table designed with assumption that live load does not exceed 70% of total load.

FLOOR LOAD TABLES

89 x 38, 4 x 2 CHORDS

292, 11½" DEEP

CLEAR SPAN	LIVE LOAD LIMIT Note 1			LIVE LOAD LIMIT Note 2		
	SPF 1 & 2	SPF SS	2100	SPF 1 & 2	SPF SS	2100
4267	1883	2466	2481	1883	2466	2481
14'0"	**129**	**169**	**170**	**129**	**169**	**170**
4572	1635	2277	2291	1635	2277	2291
15'0"	**112**	**156**	**157**	**112**	**156**	**157**
4877	1445	2116	2131	1445	2116	2131
16'0"	**99**	**145**	**146**	**99**	**145**	**146**
5182	1284	1926	1985	1284	1926	1985
17'0"	**88**	**132**	**136**	**88**	**132**	**136**
5486	1138	1722	1868	1138	1635	1868
18'0"	**78**	**118**	**128**	**78**	**112**	**128**
5791	1022	1547	1751	1022	1328	1751
19'0"	**70**	**106**	**120**	**70**	**91**	**120**
6096	919	1386	1664	919	1080	1430
20'0"	**63**	**95**	**114**	**63**	**74**	**98**
6400	832	1240	1576	803	890	1182
21'0"	**57**	**85**	**108**	**55**	**61**	**81**
6706		1080	1445		744	978
22'0"		**74**	**99**		**51**	**67**
7010		949	1225			817
23'0"		**65**	**86**			**56**
7315		832	1109			
24'0"		**57**	**76**			
7620			996			
25'0"			**68**			

IMPORTANT NOTES:

1. Based on floor live load deflection of L/360.
2. Based on CMHC criteria, live load deflection of L/360 or 13 mm, (½") whichever is less.
3. Metric loading capacity in N/m.
4. Imperial loading capacity in PLF.
5. Table designed with assumption that live load does not exceed 70% of total load.

FLOOR LOAD TABLES

89 x 38, 4 x 2 CHORDS

317, 12½" DEEP

CLEAR SPAN	LIVE LOAD LIMIT Note 1			LIVE LOAD LIMIT Note 2		
	SPF 1 & 2	SPF SS	2100	SPF 1 & 2	SPF SS	2100
4572	1824	2539	2539	1824	2539	2539
15'0"	**125**	**174**	**174**	**125**	**174**	**174**
4877	1605	2350	2350	1605	2350	2350
16'0"	**110**	**161**	**161**	**110**	**161**	**161**
5182	1416	2145	2204	1416	2145	2204
17'0"	**97**	**147**	**151**	**97**	**147**	**151**
5486	1270	1912	2072	1270	1912	2072
18'0"	**87**	**131**	**142**	**87**	**131**	**142**
5791	1138	1707	1941	1138	1605	1941
19'0"	**78**	**117**	**133**	**78**	**110**	**133**
6096	1022	1547	1839	1022	1299	1737
20'0"	**70**	**106**	**126**	**70**	**89**	**119**
6400	934	1401	1737	934	1065	1430
21'0"	**64**	**96**	**119**	**64**	**73**	**98**
6706	846	1284	1649	817	890	1182
22'0"	**58**	**88**	**113**	**56**	**61**	**81**
7010	773	1153	1532	686	744	992
23'0"	**53**	**79**	**105**	**47**	**51**	**68**
7315		1022	1343			846
24'0"		**70**	**92**			**58**
7620		905	1197			
25'0"		**62**	**82**			
7925		803	1065			
26'0"		**55**	**73**			

IMPORTANT NOTES:
1. Based on floor live load deflection of L/360.
2. Based on CMHC criteria; live load deflection of L/360 or 13 mm, (½") whichever is less.
3. Metric loading capacity in N/m.
4. Imperial loading capacity in PLF.
5. Table designed with assumption that live load does not exceed 70% of total load.

FLOOR LOAD TABLES

89 x 38, 4 x 2 CHORDS

406, 16" DEEP

CLEAR SPAN	LIVE LOAD LIMIT Note 1			LIVE LOAD LIMIT Note 2		
	SPF 1 & 2	SPF SS	2100	SPF 1 & 2	SPF SS	2100
4877	2174	3211	3211	2174	3211	3211
16'0"	**149**	**220**	**220**	**149**	**220**	**220**
5486	1722	2583	2802	1722	2583	2802
18'0"	**118**	**177**	**192**	**118**	**177**	**192**
6096	1386	2087	2481	1386	2087	2481
20'0"	**95**	**143**	**170**	**95**	**143**	**170**
6706	1153	1737	2233	1153	1562	2058
22'0"	**79**	**119**	**153**	**79**	**107**	**141**
7315	963	1459	2014	963	1109	1459
24'0"	**66**	**100**	**138**	**66**	**76**	**100**
7952	817	1240	1722	730	803	1065
26'0"	**55**	**85**	**118**	**50**	**55**	**73**
8534		1065	1474			788
28'0"		**73**	**101**			**54**
9144		919	1197			
30'0"		**63**	**82**			
9754		759	992			
32'0"		**52**	**68**			
10363			832			
34'0"			**57**			

IMPORTANT NOTES:

1. Based on floor live load deflection of L/360.
2. Based on CMHC criteria; live load deflection of L/360 or 13 mm, (½") whichever is less.
3. Metric loading capacity in N/m.
4. Imperial loading capacity in PLF.
5. Table designed with assumption that live load does not exceed 70% of total load.

FLOOR LOAD TABLES

89 x 38, 4 x 2 CHORDS

457, 18" DEEP

CLEAR SPAN	LIVE LOAD LIMIT Note 1			LIVE LOAD LIMIT Note 2		
	SPF 1 & 2	SPF SS	2100	SPF 1 & 2	SPF SS	2100
6096	1591	2408	2875	1591	2408	2875
20'0"	**109**	**165**	**197**	**109**	**165**	**197**
6706	1313	1985	2569	1313	1985	2569
22'0"	**90**	**136**	**176**	**90**	**136**	**176**
7315	1109	1678	2320	1109	1430	1883
24'0"	**76**	**115**	**159**	**76**	**98**	**129**
7925	949	1430	1985	949	1036	1372
26'0"	**65**	**98**	**136**	**65**	**71**	**94**
8534	817	1226	1707	701	773	1022
28'0"	**56**	**84**	**117**	**48**	**53**	**70**
9144		1065	1503			773
30'0"		**73**	**103**			**53**
9754		934	1284			
32'0"		**64**	**88**			
10363		817	1065			
34'0"		**56**	**73**			
10973			905			
36'0"			**62**			
11582			773			
38'0"			**53**			

IMPORTANT NOTES:

1. Based on floor live load deflection of L/360.
2. Based on CMHC criteria; live load deflection of L/360 or 13 mm, (½") whichever is less.
3. Metric loading capacity in N/m.
4. Imperial loading capacity in PLF.
5. Table designed with assumption that live load does not exceed 70% of total load.

FLOOR LOAD TABLES

89 x 38, 4 x 2 CHORDS

508, 20" DEEP

CLEAR SPAN	LIVE LOAD LIMIT Note 1			LIVE LOAD LIMIT Note 2		
	SPF 1 & 2	SPF SS	2100	SPF 1 & 2	SPF SS	2100
6096	1810	2729	3269	1810	2729	3269
20'0"	**124**	**187**	**224**	**124**	**187**	**224**
6706	1489	2247	2919	1489	2247	2919
22'0"	**102**	**154**	**200**	**102**	**154**	**200**
7315	1255	1897	2641	1255	1810	2379
24'0"	**86**	**130**	**181**	**86**	**124**	**163**
7925	1065	1605	2247	1065	1313	1737
26'0"	**73**	**110**	**154**	**73**	**90**	**119**
8534	919	1386	1941	890	978	1299
28'0"	**63**	**95**	**133**	**61**	**67**	**89**
9144	803	1211	1693	671	744	978
30'0"	**55**	**83**	**116**	**46**	**51**	**67**
9754		1065	1489		584	759
32'0"		**73**	**102**		**40**	**52**
10363		949	1313			
34'0"		**65**	**90**			
10973		846	1153			
36'0"		**58**	**79**			
11582		744	978			
38'0"		**51**	**67**			
12192			832			
40'0"			**57**			

IMPORTANT NOTES:

1. Based on floor live load deflection of L/360.
2. Based on CMHC criteria; live load deflection of L/360 or 13 mm, (½") whichever is less.
3. Metric loading capacity in N/m.
4. Imperial loading capacity in PLF.
5. Table designed with assumption that live load does not exceed 70% of total load.

3.0 REGULATORY TESTING, EVALUATION AND ACCEPTANCE

3.1 Introduction

In order to gain regulatory approval for use in Canadian residential construction the following testing and evaluations of the Wood "I" were carried out:

a) the Canada Mortgage and Housing Corporation prepared Building Material Evaluation Report No. 10458;

b) the Building Standards Branch of Alberta Labour assessed the fire resistance rating of a typical floor/ceiling assembly; and

c) the Underwriters' Laboratories of Canada prepared a report on the testing of the Wood "I" for use in a combustible floor and ceiling assembly, file CR 1238, Design No. M508.

The results of these assessments are documented in the reports which follow.

These tests and evaluations were carried out after an extensive design development and test program conducted at the Calgary facilities of Jager Industries. Included in the test program was a long term creep test which the Wood "I" passed.

3.2 Canada Mortgage and Housing Corporation Building Material Evaluation Report No. 10458.

Canada Mortgage and Housing Corporation (C.M.H.C.) evaluated the Wood "I" in order to determine its acceptability for use in residential construction financed or insured under the National Housing Act. In addition, C.M.H.C. assessed the product's compliance with applicable national codes and standards.

The following section contains a copy of C.M.H.C. building Material Evaluation Report No. 10458 which outlines the usage and limitations of the Wood "I", and which assesses the performance of the product.

Canada Mortgage and Housing Corporation
Société canadienne d'hypothèques et de logement

National Office
682 Montreal Road
Ottawa Ontario
K1A 0P7

Bureau National
682 chemin Montréal
Ottawa (Ontario)
K1A 0P7

DIVISION 06190

BUILDING MATERIAL EVALUATION REPORT

EVALUATION REPORT NO.: 10458
ISSUE DATE: 83-09-23
DATE OF REVISION: 84-08-23
NUMBER OF PAGES: 8

THIS REPORT CONTAINS NO ENDORSEMENT, WARRANTY, OR GUARANTEE, EXPRESS OR IMPLIED ON THE PART OF CMHC. CMHC ACCEPTS NO RESPONSIBILITY FOR THE PERFORMANCE OF ANY PRODUCT OR SYSTEM DESCRIBED HEREIN.

"TTS WOOD-I"

1.0 PRODUCT

Wood floor and roof truss.

2.0 PROPONENT

Jager Industries Inc., 8835 MacLeod Trail S.W., Calgary, Alberta, T2H 0M2.

3.0 MANUFACTURED AT

Jager Industries Inc., TTS Wood-I Division, 4334-68th Avenue S.E., Calgary, Alberta.

4.0 DESCRIPTION

The "TTS Wood-I" is an "I" section wood beam fabricated with machine stress rated or visually graded sawn lumber chords and a graded waferboard web. The continuous chords are 38 mm deep and are either 64 mm or 89 mm wide. The webs are either 9.5 mm thick waferboard for joists up to 508 mm deep and 15.9 mm thick waferboard for joist depths up to 600 mm. Two 3 mm wide by 12.7 mm deep saw kerfs are cut into the wide face of each chord and these kerfs are splayed five degrees from the vertical. A 12.7 mm saw kerf is cut into each edge of the waferboard to allow for a tongue-and-groove mating with the chords. The web and chords are pressure glued in a pinch-roll assembly.

No chord splicing is done for joist lengths 6096 mm or less whereas for joists longer than 6096 mm, the chords are finger jointed and purchased from a CSA certified mill. The waferboard web sections are installed in 4877 mm, 2438 mm and 1219 mm lengths. The web butt joints are strategically placed near the center of the joists and they are not glued or spliced. The webs may have 50 mm diameter round holes spaced a minimum distance of 600 mm on center. The holes are located along the center line of the web with the center line of the holes nearest to the joist ends not closer than 914 mm to the end of the joist.

A drawing with a cross-section of the "TTS Wood-I" floor truss is appended to this report to illustrate its unique configuration.

Canada

5.0 USAGE AND LIMITATIONS

"TTS Wood-I" floor and roof trusses are permitted for use in construction financed or insured under the National Housing Act. They are also permitted where the floor assembly is required to have a fire resistance rating of one hour. The usage of "TTS Wood-I" floor and roof trusses are subject to the following conditions:

(1) "TTS Wood-I" floor and roof trusses shall be designed in accordance with the requirements of CAN3-086-M80, "Code for Engineering Design in Wood".

(2) The drawings and related documents shall bear the authorized professional seal and signature of a professional engineer or architect skilled in wood design and licensed to practice under the appropriate provincial or territorial legislation. The drawings shall show the applicable design loads and deflections.

The allowable spans for "TTS Wood-I" floor and roof trusses, however, may conform to the spans shown in Table 1 for the uniform live loads shown in the table.

(3) Lumber for top and bottom chords shall be continuous and identified by a grade stamp to indicate its grade as determined by the requirements of NLGA Special Product Standard SPS 1-81 for Canadian lumber. Moisture content of the lumber shall not exceed 19 per cent at the time of fabrication of the floor truss.

(4) The top or bottom chord, unless specified in an approved detail, shall not be cut, drilled or notched.

(5) End-jointed lumber shall be grade stamped with the marks "NLGA SPS 1-81" and "CERT FGR JNT".

(6) The waferboard web shall conform to the requirements of CAN3-0188.2-M78, "Waferboard", and shall be an exterior type.

(7) The moisture content differential between the lumber and the waferboard shall not exceed 5 per cent for good adhesive bonding at the time of assembly.

(8) The waferboard to chord adhesive shall conform to the requirements of CSA 0112.7-M 1977, "Resorcinol and Phenol-Resorcinol, Resin Adhesives for Wood (Room and Intermediate Temperature Curing)" for Type I.

(9) The "TTS Wood-I" floor and roof truss shall be restrained from twisting at the end supports and intervals between the supports not exceeding 2.1 m.

Such restraint may be provided at end supports by toe nailing to the support or by end nailing the truss to the header joist. Restraint at the intermediate locations or at the ends may be provided by not less than 19 mm by 64 mm or 38 mm by 38 mm cross bridging or 25 mm by 3.2 mm steel strapping or 19 mm by 89 mm continuous wood strapping nailed to each truss and fastened at each end to the header or sill to prevent over-all movement. Blocking, tightly fitted between trusses and securely nailed in place, is also acceptable for restraining truss twisting.

(10) The "TTS Wood-I" floor and roof truss shall have not less than 38 mm length of end bearing.

(11) Web stiffeners, as detailed in the manufacturer's specifications, are required at all supports for truss depths exceeding 400 mm.

(12) The roof assembly shall be designed and constructed to permit the installation of the required insulation in a manner which will not reduce the flow of air through vents or through any portion of the roof space or attic.

Where the interior finish is applied directly against the underside of the roof truss, a minimum clearance of 150 mm shall be maintained between the underside of the roof sheathing and the top of the insulation, and this space shall be cross-ventilated to the adjacent truss spaces by means of holes in the web with a minimum diameter of 75 mm and spaced at 600 mm centers. Where holes are not provided in the webs, cross members at least 89 mm deep shall be installed over and across the roof trusses and a minuimum clearance of 64 mm shall be maintained between the underside of these cross members and the top of the insulation.

6.0 ASSESSMENT

6.1 Compliance to Building Codes and Standards

In the opinion of the Materials Evaluation Department, "TTS Wood-I" floor and roof trusses comply with the following codes and standards:

(1) National Building Code of Canada 1980, Sections 4.1 and 4.3;
(2) Residential Standards 1980, Sections 4.B and 4.E;
(3) CAN3-086-M80, Code for the Engineering Design of Wood;
(4) ULC CAN4-S101-M82, Standard Methods of Fire Endurance Tests of Building Construction and Materials; and
(5) CMHC "Load Test Procedures for Floor Framing Systems for Houses and Small Buildings".

6.2 Performance

(a) Load Testing

Testing of the "TTS Wood-I" floor and roof trusses was performed at the expense of the proponent by EBA Engineering Consultants Limited of Calgary, Alberta in accordance with the requirements of CMHC "Load Test Procedures for Floor Framing Systems for Houses and Small Buildings". Testing was conducted on three full scale trusses with one retest permitted if a truss fails to meet the performance criteria. The wood trusses had an average depth of 243 mm and an average web thickness of 9.1 mm, and they were tested at their design clear span of 5.5 m. Results of the testing were obtained from Test Report No. 304-1863-01 dated 31 May 1983 and are summarized as follows:

Test Procedure	Requirement	Result	
		Truss No.	Deflection (mm)
A live load of 1.92 kN/m^2 plus a dead load of 0.5 kN/m^2 are applied to the truss.	Deflection due to live load not to exceed the lessor of L/360 or 13 mm.	1 2 3	7 9 3
Live load plus dead load is maintained for one hour.	Increase in deflection not to exceed 25% of initial deflection.	All increases in deflection were within permitted limit.	
Live load is removed.	Difference between deflection measured prior to application of live load and after its removal not to exceed L/1440.	All trusses met requirement.	
A load of twice live load and dead load is applied for 24 hours.	Truss shall not collapse.	All trusses met requirement.	

(b) Fire Endurance Test

A fire endurance test was undertaken by Underwriters' Laboratories of Canada to establish the fire resistance rating of floor and ceiling assembly using "TTS Wood-I" trusses. The fire test was carried out in accordance with the requirements of ULC CAN4-S101-M82. The assembly is described and listed as Design No. M507 in Volume II of ULC's List of Equipment and Materials.

According to ULC's Report No. CR1238, dated 1983-09-12, it was concluded that the floor and ceiling assembly using "TTS Wood-I" trusses will afford a 1 h resistance to the passage of flame and the dangerous transmission of heat, and it will support the design load of 3.35 kPa for the period implicit in the assigned fire resistance rating.

The "TTS Wood-I" floor and roof trusses were not tested for resistance to sound.

6.3 Longevity

The manufacturer warrants the components of the "TTS Wood-I" floor and roof trusses to be free from defects in material and workmanship under normal use and service in compliance with the manufacturer's instructions and specifications. Therefore, provided the "TTS Wood-I" floor and roof trusses are used under dry service conditions, it is the opinion of the Materials Evaluation Department that they will perform satisfactory for the life of the building within their design loads.

7.0 INSTALLATION

(1) The "TTS Wood-I" floor and roof truss must be installed in strict accordance with the manufacturer's instructions.

(2) Small holes less than 38 mm diameter may be drilled neatly into the web to allow passage of plumbing, wiring and conduit.

(3) The "TTS Wood-I" floor and roof trusses must be protected from moisture at all times.

(4) The "TTS Wood-I" floor and roof truss must be handled carefully to prevent damage during shipping, storage, installation and application.

(5) The "TTS Wood-I" floor and roof truss will not support workmen or other loads during erection until properly installed and restrained.

(6) Damaged or defective trusses shall not be used or repaired.

8.0 IDENTIFICATION

"TTS Wood-I" floor and roof trusses are identified on the waferboard web at intervals not exceeding three metres with the following:

(1) Manufacturer's name or logo; and
(2) The phrase "See CMHC Evaluation Report No. 10458".

NOTES

Readers are advised to confirm that this report has not been withdrawn or superseded by a later issue by contacting the Materials Evaluation Department at (613) 748-2280 or any CMHC local office.

Readers are asked to refer to limitations imposed by CMHC on the interpretation and use of this report. These limitations are included in the introduction to the "Manual of Building Materials Evaluation Reports" of which this report is part.

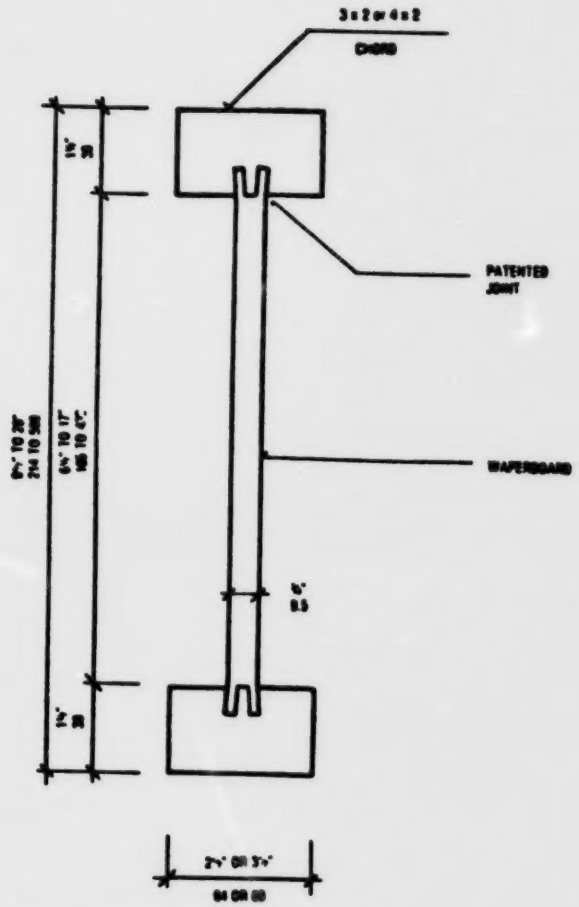
TABLE 1

MAXIMUM CLEAR SPANS (mm) FOR "TTS WOOD-I" FLOOR AND ROOF TRUSSES

Commercial Designation	Chord Grade	Actual Size (mm)	Truss Depth (mm)	Truss Spacing (mm) 300	400	500	600
Spruce-Pine-Fir	1	38 x 64	242	4877	4547	4166	3708
			292	5436	4877	4724	4216
Spruce-Pine-Fir	1	38 x 89	242	5509	4877	4775	4267
			292	6248	5410	4953	4851
			406	7671	6655	6070	5436
MSR	1650	38 x 89	242	5918	5486	5080	4877
			292	6604	6147	5766	5156
			406	7976	7417	7087	6325
MSR	2100	38 x 89	242	6172	5740	5486	4877
			292	6908	6426	6147	5791
			406	8331	7747	7391	6985

Note: The above span table was calculated using the following uniform load criteria:

Live load: 1.92 kN/m^2
Dead load: 0.50 kN/m^2 for spans of 4877 mm and less
Dead load: 1.00 kN/m^2 for spans greater than 4877 mm
Maximum live load deflection: 13 mm



TTS WOOD I by Jager Industries Inc., Calgary, Alberta

Product Description
The Wood I joist is an "I" section beam fabricated with machine stress rated or visually graded sawn lumber chords and a graduated waferboard web. All chords are 38mm deep and may be 64mm or 89mm wide. The web is made from 9.5mm thick waferboard for joists up to 500mm deep and 15.9mm thick for joist depths up to 600mm. Two, 3mm wide, 12.7mm deep, saw kerfs are cut into the wide face of each chord and these kerfs are splayed five degrees from the vertical. A 12.7mm saw kerf is cut into each edge of the waferboard to allow for a tongue and groove mating with the chords. The web and flanges are pressure glued in a pinch roll assembly. All web joints are butt joints and no web joint is to occur within 600mm of the beam ends, interior supports or chord splices. Various methods of chord splicing may be incorporated as indicated by approved details.

HANDLING and Installation Notes
1. Do not cut, drill or notch the top or bottom chord unless specified in an approved detail.
2. Small holes may be cut into the web to allow passage of plumbing, wiring and conduit. For specific information on holes larger than 38mm diameter see approved details.
3. Wood I components should be protected from moisture at all times.
4. Wood I components must be handled carefully to prevent damage during shipping, storage, installation and application.
5. All fasterungs, resistance to uplift or any member not specifically detailed are subject to local approval.
6. Compressurn chords are to be fully laterally restrained.
7. Wood I will not support workmen or other loads until properly installed and restrained.
8. Web stiffeners may be required to achieve full structural performance. See approved detail.

TTS

ROOF ..... ☐	LOADING
FLOOR ..... ☐	..... LIVE
SPACING	..... DEAD
..... O C	..... TOTAL
CHECKED BY	CODES
INSTALLATION	CSA/C ..... ☐
	NBC 88 Part 9 ☐
	NBC 88 Part 4 ☐
	DRWG NO

3.3 Evaluation of Fire Resistance by the Building Standards Branch of Alberta Labour

The Building Standards Branch evaluates building products for compliance with the intent of the 1981 Alberta Building Code. It was determined that a floor/ceiling assembly built as shown in the following product listing bulletin has an unrestrained fire resistance rating of 60 minutes.

The impact of the product listing bulletin ('STANDATA') contained in this section is that it constitutes acceptance of the use of the assembly in buildings in Alberta.

Alberta
LABOUR
General Safety Services Division
Building Standards Branch

705, 10808 - 99 Avenue, Edmonton, Alberta, Canada T5K 0G2 403/427-8265

1984 01 11

Mr. Lorne Mercier
Technical Sales Representative
TTS Systems
8835 Macleod Trail S.W.
Calgary, Alberta
T2H 0M2

Dear Mr. Mercier:

Re: FIRE RESISTANCE RATING OF FLOOR CEILING ASSEMBLY

The attached product listing bulletin constitutes acceptance of the use of the assembly in buildings in Alberta. Copies of the bulletin will be sent by us in the near future to building officials throughout Alberta.

If you wish to distribute copies of the bulletin to designers, contractors and other potential customers, you may make direct copies. No other material may be added to the bulletin and the bulletin shall not be changed by deletion or rewording.

The bulletin is the property of the Building Standards Branch and is to be treated as technical information provided by the Branch for the purpose of informing construction industry in Alberta about new assembly that can be used and the conditions of acceptance. The bulletin is not to be used as or included with other advertising material.

The bulletin will be reviewed on or before the review date and may be withdrawn at any time if subsequent information is received that the assembly no longer satisfies the intent of the Alberta Building Code 1981.

Changes in materials, specification or application that affect the assembly and its acceptance should be sent to the Building Standards Branch for review.

Yours truly,

Ata Khan M.R.A.I.C.
Research & Approvals Officer

AK/sjc

PRODUCT LISTING

STANDATA

NO. 81 PL 039

CATEGORY: FIRE RESISTIVE CONSTRUCTION

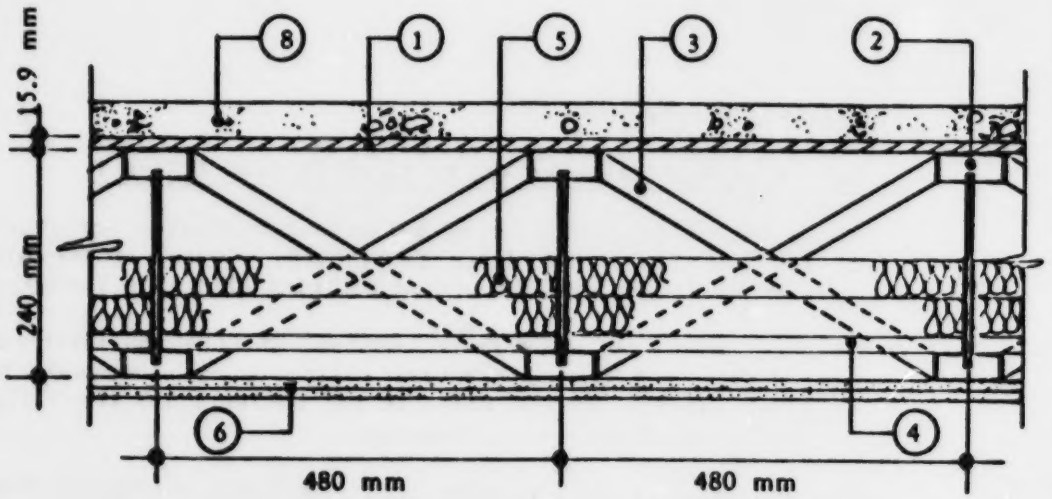
Listed pursuant to Sentence 1.5.4.2.(8) of the Alberta Building Code 1981

ISSUE DATE: 1984 01 02 **REVIEW DATE:** 1985 01 02

MANUFACTURER: Fabricators Licensed by TTS Systems

REPRESENTATIVE IN ALBERTA:
Jager Industries Inc.
8835 Macleod Trail, S.W.
Calgary, Alberta T2H 0M3

PRODUCT:



UNRESTRAINED ASSEMBLY RATING 60 MINUTES
COMBUSTIBLE CONSTRUCTION

1. SUBFLOORING .... 15.9 mm thick by 1200 mm wide sheets of exterior grade Waferboard or unsanded sheathing grade phenolic bonded spruce or Douglas Fir plywood boards, long edges tongue and groove laid perpendicular to joists with end joints staggered 1440 mm o.c. between adjacent rows and located over joists. The boards fastened to the top chord of each joist with 57 mm long nails spaced 150 mm o.c.

ISSUE OF THIS LISTING IS AUTHORIZED BY THE DIRECTOR OF BUILDING STANDARDS
D. O. MONSEN, M.R.A.I.C.

Alberta

2. JOISTS .... 240 mm minimum depth, maximum spacing 480 mm o.c. fabricated with parallel structural wood top and bottom chords and waferboard webs, designated as Type "WOOD I".

TTS SYSTEMS, DIVISION OF JAGER INDUSTRIES LTD.

3. BRIDGING .... 38 mm x 43 mm Spruce - Pine - Fir cross bridging nailed to the top and bottom chords of the joists at mid span.

4. WOOD STRAPPING .... 19 mm x 89 mm Spruce - Pine - Fir strapping supported by bottom chords of joists and located at 500 mm o.c.

5. MINERAL WOOL BLANKETS .... Two layers of 38 mm thick sound attenuation blanket insulation fitted between each pair of joists and supported by the wood strapping at butt joints of the lower layer. The butt joints in two layers are to be staggered.

CANADIAN GYPSUM COMPANY LIMITED

6. GYPSUM BOARD .... Two layers of 12.7 mm thick gypsum board.

First layer installed with long dimension perpendicular to joists, end joints offset 960 mm between adjacent rows and located directly beneath the joists. Secured to the underside of the joists with 32 mm long Type "W" drywall screws located 30 mm from edges and 150 mm o.c. at the end joints and 300 mm o.c. at intermediate supports.

Second layer installed with end joints offset at least 960 mm with respect to the first layer and located directly beneath the joists. Longitudinal side joints offset 600 mm with respect to first layer. Secured to the underside of the joists with 57 mm long Type "S" drywall screws located 30 mm from edges and 150 mm o.c. at the end joints and 300 mm o.c. at intermediate supports.

CANADIAN GYPSUM COMPANY LIMITED (Fire Code C)

7. All exposed gypsum board joints reinforced with paper tape and finished with two coats of joint compound. Fastener heads are to be covered with joint compound.

8. FLOOR TOPPING (Optional) .... Non-structural cementious floor topping may be placed above the sub-flooring.

3.4 Fire Resistance Rating Test Carried Out by the Underwriters' Laboratories of Canada

a) ULC assessment of fire test page 33.
b) ULC test report page 35.

The Underwriters' Laboratories of Canada carry out all fire tests in this country in accordance with the Canadian Building Code and other standards. Building assemblies built according to the tested assemblies are accepted by the Canadian Building Code as having the same fire resistance rating as the tested assembly.

The following reports contain a description of the tested assembly, an assessment of the test, photographs and diagrams.

INCORPORATED 1920

UNDERWRITERS' LABORATORIES OF CANADA

General Offices and Testing Station 7 CROUSE ROAD, SCARBOROUGH, ONTARIO M1H 3A9 Telephone 757 3811 Area Code 416
Telex 06 963643

In Replying Please Refer to

CR1238
84T221

August 31, 1984

Mr. John M. Little
Jager Industries Inc.
TTS Systems Division
630 Rivermede Road, Unit 12
Concord, Ontario
L4K 2H7

Subject: "Wood I" - 1 h Fire Test

Dear John:

As requested, this letter is to confirm the results of the fire test of a floor/ceiling assembly conducted August 28, 1984.

A brief description of the assembly follows:

Sub-Flooring - 15.9 mm thick T ¢ G exterior grade wafer board. End joints butted over beams.

Bridging - 50 by 50 mm spruce cross bridging.

Structural Components - "Wood - I", prefabricated beams, 240 mm deep, 38 by 89 mm top and bottom chords. Manufactured by Jager Industries Inc., TTS Systems Division.

Resilient Furring Channels - 0.60 mm galvanized steel, spaced 600 mm. Fastened perpendicular to beams with 38 mm screws at every beam. Additional pieces placed immediately adjacent to channels for attachment of gypsum board end joints. Ends of additional pieces to extend beyond side of end joint and fastened to next beam at each side.

Gypsum Wallboard - 15.9 mm thick 1200 mm wide, ULC labelled. Manufactured by Canadian Gypsum Company, designated as "Firecode C". Fastened to resilient channels with 32 mm long type "S" screws spaced 300 mm OC. Long edges of boards

2 ...

perpendicular to channels and located between joists. Butted end joints staggered 600 mm OC and fastened at additional furring channel as described above.

The assembly as described above, successfully endured a 1 hour fire test conducted in accordance with CAN4-S101-M82, Standard Methods of Fire Endurance Tests of Building Construction and Materials. The assembly will be assigned an Unrestrained Assembly Rating of 1 hour and will be designated as Design No. M508.

We trust that this will meet your immediate needs. We expect to issue our formal report in four to six weeks.

Yours very truly,

Donald F. Falconer, P.Eng.,
Project Engineer
Construction Materials.

Reviewed by:

Peter Higginson, P.Eng.,
Managing Engineer,
Construction Materials.

EL/nd

INCORPORATED 1970

UNDERWRITERS' LABORATORIES OF CANADA

General Offices and Testing Station 7 CROUSE ROAD, SCARBOROUGH, ONTARIO M1R 3A9 Telephone 757 3611 Area Code 416
Telex 06-963643

In Replying
Please Refer to

File CR1238
Application No. 84T221
October 4, 1984

REPORT

on

STRUCTURAL COMPONENTS FOR USE
IN A COMBUSTIBLE FLOOR AND CEILING ASSEMBLY

Jager Industries Inc., TTS Systems Division
Calgary, Alberta

I N T R O D U C T I O N

This Report describes an investigation that was undertaken to establish the fire resistance rating of a floor and ceiling construction. The performance of the assembly and its component parts was assessed by subjecting it to a fire endurance test in accordance with the Standard Methods of Fire Endurance Tests of Building Construction and Materials, CAN4-S101-M82.

The fire test was supplemented by other tests and examinations intended to furnish information concerning the properties of materials employed in the tested assembly.

At the conclusion of this Report, reference is made to Design No. M508 which has been established as a result of the investigation described herein.

D E S C R I P T I O N

MATERIALS COVERED BY THIS REPORT:

The devices covered by this Report are structural components.

GENERAL CHARACTER AND USE:

The structural components covered by this Report are "I" beams incorporating wood top and bottom chords and wafer board web members. The beams support wafer board flooring and are protected on the underside of the assembly by a layer of 15.9 mm thick, ULC labelled gypsum wallboard.

The floor and ceiling assembly described by this Report is intended for use in building construction where a 1h fire resistance rating is required.

MARKING:

Each structural component covered by this Report is eligible to bear the label Underwriters' Laboratories of Canada reading:

Underwriters' Laboratories of Canada
Listed
Structural Component

For Use as a Component in the Following
Fire Rated Assemblies:

together with a list of the applicable assemblies including Design No. M508.

Each sheet of wallboard covered by this Report is eligible to bear the label of Underwriters' Laboratories of Canada reading:

Underwriters' Laboratories of Canada
Listed
Wallboard
Issue No._____C

together with a list of the applicable assemblies including Design No. M508.

MATERIALS:

The following is a description of the materials used in the assembly.

Beams - The beams used to support the assembly were fabricated from No. 1 Grade stress graded kiln dried spruce top and bottom chords and wafer board webs. The chords measured 38 by 89 mm. The wafer board web measured 10 mm thick and was continuous for the length of the beam. The chords were continuous with no joints. Exact details of the construction of the beams are considered to be proprietary in nature and are on file at Underwriters' Laboratories of Canada for use in the Follow-Up Service Programme. The overall dimensions of the beams were 89 by 240 by 4267 mm.

Bridging - The beams were braced at midspan with 50 by 50 mm wood cross bridging.

Flooring - The flooring was 15.9 mm thick by 1219 mm wide tongue and grooved, exterior grade wafer board.

Wallboard, Gypsum - The ceiling membrane was formed a single layer of 15.9 mm thick gypsum wallboard designated as "Firecode C". This wallboard was produced under the Follow-Up Service of Underwriters' Laboratories of Canada. Refer to the "Marking" section for details of the label.

Resilient Furring Channels - Formed of 0.52 mm thick galvanized steel, hat shaped, with overall dimensions of 64 mm wide by 22 mm deep.

THE INVESTIGATION

The object of the investigation was to establish a Fire Resistance Rating for the Floor and Ceiling Assembly described herein by subjecting the assembly to a fire exposure in accordance with the Standard Methods of Fire Endurance Tests of Building Construction and Materials, CAN4-S101-M82.

EXAMINATION AND TEST RECORD

ERECTION OF TEST ASSEMBLY:

The floor and ceiling assembly was constructed in a test frame in accordance with the methods indicated by the submittor and as shown in Fig. 2 and 3. The assembly was constructed by workmen in the employ of the submittor, and under the observation of the Laboratories' staff.

The assembly was supported by two steel angles measuring 100 by 100 by 10 mm thick along the north and south edges of the test frame.

A header of 38 by 235 mm lumber was nailed to the ends of the beams with four 83 mm long spiral nails at each beam. The assembly consisting of beams and header was set onto 38 by 89 mm lumber plate that had been placed upon the steel angles. Each end of each beam was nailed to the 38 by 89 mm wood plate with two 83 mm spiral nails. The beams were spaced 488 mm OC except for the two very end beams which were at 305 mm OC.

Web stiffeners consisting of 38 by 89 by 165 mm long pieces of spruce lumber were nailed at each side of each beam end with 83 mm long spiral nails through the top and bottom chord over the bearing points.

The wafer board flooring was laid with the long tongued and grooved edges perpendicular to the beams. The boards were fastened to the top chord of each beam with 50 mm spiral nails spaced 150 mm OC. The board ends were butted over beams and the joints were staggered 984 mm OC.

Cross bridging consisting of nominal 50 by 50 by 685 mm long lumber was nailed to the top and bottom chords of the beams along the east-west certreline of the assembly.

On the ceiling side of the assembly, the resilient furring channels were fastened perpendicular to the beams, spaced 610 mm OC. Two 42 mm long type "S" screws were used to fasten the channels at each beam. Additional furring channels 2134 mm in length, were fastened to the beams at the gypsum board end joint locations so that the end of each board could be fastened to a channel. These additional channels were fastened with two 42 mm long type "S" screws at each beam and extended beyond the gypsum board edges to the next beam.

A layer of 15.9 mm thick gypsum board was installed with the long edges of the boards parallel with the beams and perpendicular to the furring channels. The boards were fastened to the furring channels with 32 mm long type "S" screws spaced 300 mm OC and 25 mm from board ends. The long edges of the boards were located between the beams and the butted end joints were staggered 610 mm OC.

All wallboard joints on the ceiling surface were covered with joint tape and compound.

The appearance of the exposed and unexpected surfaces before the fire test is shown by Fig. 4 and 5 respectively.

FIRE ENDURANCE TEST:

SAMPLE

The test assembly was constructed as described previously under "Erection of Test Assembly" using materials described in the section "Materials".

METHOD

Fire Exposure - The furnace was fired in accordance with the standard time-temperature curve shown in the Standard Methods of Fire Endurance Tests of Building Construction and Materials, CAN4-S101-M82, using a floor furnace and test equipment as prescribed by the Standard.

Temperature Measurement - The temperature in the furnace chamber were measured by 12 thermocouples placed symmetrically in the chamber and located 300 mm below the exposed surface as shown in Fig. 6.

The unexposed surface temperatures were measured by 11 thermocouples, each covered with a 150 by 150 mm dry asbestos pad, located as shown in Fig. 7.

Temperatures on the beams were measured by 33 thermocouples located as shown in Fig. 8.

Deflection Measurement - Vertical deflection of the assembly was measured at the five positions located as shown in Fig. 9.

Loading - The assembly was loaded by means of hydraulic jacks and an articulated load distribution system so as to provide a uniformly distributed live load of 2.63 kPa for combined dead and live load of 3.35 kPa. It was determined that this load developed the maximum allowable combined stress interaction for the beams. The load was applied to the assembly on the day of test.

General - Throughout the test, observations were made of the character of the fire and its control, the condition of the exposed and unexposed surfaces, and all developments pertinent to the fire resistive performance of the assembly.

RESULTS

Character and Distribution of Fire - The furnace fire was luminous and well distributed. The temperatures substantially followed the Standard Time-Temperature Curve as shown as Fig. 6.

Observations of the Exposed Surface -

Time (min)	Observation
1.5	- wallboard face darkening
4.5	- paper is now peeling off the wallboard face. Cracking and fall-off of joint compound noted.
13	- most of first layer of joint compound has fallen off. Gypsum board faces now mostly white in colour as 90 per cent of the paper has burned and flaked off.
15	Compound has come off approximately 25 per cent of all screw locations.
19	- Joint tape has come off approximately one half of the most westerly north-south wallboard joint.
22	- all joint tape has come off of the centre and westerly north-south wallboard joints.
27	- joint compound remains of one half of screw locations.
29	- Slight sagging of the gypsum board is now apparent, between furring channels along the north-south joints.
30	- all joint tape is now off
34	- frequent popping sounds can now be heard from the assembly
52	- some lazy flames and whiffs of black smoke now seen along the gypsum board joints.
54	- a sudden vibration jolted the west half of the assembly.
56	- smoke and flames observed at 52 min are much heavier now.
60 min 10 s	- gas off

Observations of the Unexposed Surface -

Time (min)	Observations
27	- light wisps of smoke from various locations along perimeter of assembly
31	- wisps of smoke now at approximately 1200 mm from south edge at centre wafer board joint
35	- crackling sounds from assembly now
54	- sudden drop of floor noted, centred at a point 1200 mm from south and west edges of assembly
55	- smoke now from all wafer board joints
60 min 10 s	- gas off

Deflection of the Assembly - The vertical deflection of the assembly during the fire endurance test is shown in Fig. 9.

Temperature of the Assembly - The unexposed surface temperatures recorded during the fire endurance test are shown in Fig. 7. At 60 min the average measured temperature on the unexposed surface was 91°C and the maximum recorded individual unexposed surface temperature was 114°C.

The temperature at the bottom chords of the joists increased by an average of 139°C after 24 min of the fire endurance test.

GENERAL

The maximum permitted average rise above the initial temperature of the unexposed surface is 139°C and the maximum permitted individual rise above the initial temperature of the unexposed surface is 181°C.

The limiting temperature conditions, based on the initial ambient temperature of 24°C were as follows:

Maximum average limiting temperature - 163°C
Maximum individual temperature - 205°C

The limiting temperature conditions were not attained during the 60 min fire test.

OBSERVATIONS AFTER TEST:

The appearance of the assembly immediately after the fire test is shown by Fig. 10.

All of the typsum wallboard remained in place for the entire duration of the fire test.

Fig. 11 shows the assembly after cooling. The majority of the gypsum wallboard had fallen during the cooling process. The beams and waferboard were heavily charred. The webs of the beams had been extensively consumed by the fire.

STUDY FOR CLASSIFICATION PURPOSES

The submittor requested that consideration be given to the optional use of Douglas-Fir and/or spruce plywood in lieu of the tested waferboard flooring and also to the use of concrete topping.

The addition of a non-structural concrete topping over the plywood or waferboard subfloor is expected to be beneficial both in terms of the rate of temperature development on the unexposed surface of the assembly and in terms of the deflection characteristics of the concrete.

It is judged that alternate use of non-structural concrete toppings would not compromise the rating assigned to the design.

As recorded under "RESULTS" the average and maximum individual unexposed surface temperatures were only 91°C and 114°C respectively after 60 min of fire exposure. It is judged that similar test performance would have occurred had Douglas-Fir or spruce plywood been used for the flooring.

The design will provide for use of either Douglas-Fir plywood, spruce plywood or exterior grade waferboard subflooring, tongue-and-grooved with a minimum thickness of 15.9 mm.

C O N C L U S I O N S

The following conclusions represent the judgement of Underwriters' Laboratories of Canada based upon the review of the results of the investigation described in this Report as they relate to currently established principles and previously recorded data.

FIRE RESISTIVE PROPERTIES:

The transmission of heat through the assembly during the classification period of 1h, would not be sufficient to raise the temperature of the exposed surface in excess of the permissible rise of 139°C average or 181°C at any one point.

ASSIGNED FIR RESISTANCE RATING:

It is therefore concluded that the floor and ceiling assembly represented by the construction described in this Report, when constructed of the materials and in the manner described herein will afford a 1h resistance to the passage of flame and the dangerous transmission of heat and will support the design loads for the period implicit in the fire resistance rating assigned. The wallboard ceiling membrane will afford a finish rating of 24 min.

L I S T I N G T E X T

On the basis of the foregoing, the applicable listing texts will be revised to include the Design covered by this Report as follows:

Guide No. 40 U18.20C October 4, 1984 File: CR1238

Structural Components

JAGER INDUSTRIES INC., TTS SYSTEMS DIVISION, Calgary, Alberta T2H 0M2

Addition:

Beams, designated as Type "Wood-I" for use in Design No. M508

Guide No. 40 U18.23 October 4, 1984 File CR170

Wallboard

CANADIAN GYPSUM COMPANY LIMITED, Toronto, Ontario M5W 1K8

Revision:

Under 15.9 mm Type "Sheetrock Firecode C", "Sheetrock SW Firecode C" gypsum wallboard add Design No. M508.

INVESTIGATION AND REPORT BY:

Donald F. Falconer, P. Eng.,
Project Engineer,
Construction Materials.

REVIEWED BY:

Peter Higginson, P. Eng.,
Managing Engineer,
Construction Materials.

UNDERWRITERS' LABORATORIES OF CANADA

Norman S. Pearce, P. Eng.,
Chief Engineer

INDEX OF FIGURES

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1	Submitted Loading Tables
2	Assembly During Construction
3	Assembly During Construction
4	Exposed Surface Before Fire Endurance Test
5	Unexposed Surface Before Fire Endurance Test
6	Furnace Temperatures
7	Unexposed Surface Temperatures
8	Beam Temperatures
9	Deflections
10	Exposed Surface After Fire Endurance Test
11	Unexposed Surface After Fire Endurance Test

SUBMITTED LOADING TABLES

```
OVERALL HEIGHT OF BEAM :9.5
BEAM WIDTH :3.5
CHORD HEIGHT :1.5
SECTION SHEAR CONSTANT :.552
CHORD ALLOWABLES
TENSION ALLOWABLE :750
MODULUS OF ELASTICITY :1350000
DESIGNATION :ULC9.5
SIZE :2X4
SPECIES & GRADE :SPR NO.1
WEB SPLICE <Y,N> :Y
WEB ALLOWABLES
SHEAR THROUGH THICKNESS :250
CHORD WEB SHEAR :195
EFFECTIVE WEB BENDING THICKNESS :.375
EFFECTIVE WEB SHEAR THICKNESS :.375
MODULUS OF ELASTICITY :536000
MODULUS OF SHEAR :200000
CODES AND LOADS
LOADING TYPE :1
LOAD COEFFICIENT :.125
TCLL,TCDL,BCLL,BCDL :55,5,0,10
SPACINGS (4 MAX) :24,19.2,16,12
LOAD DURATION FACTOR :1.0
LOAD SHARING FACTOR :1.1
OTHER FACTOR :1.0
LUMBER LOADING ADJUSTMENT FACTORS :1,1,1,1
DEFLECTION LOADING ADJUSTMENT FACTORS :1,1,1,1
CRITERIA FOR DEFLECTION
SPAN / ____ :360
1 = LIVE LOAD ONLY
2 = LIVE LOAD AND 1/2"
3 = TOTAL LOAD
4 = TOTAL LOAD AND 1/2"  :4
```

TABLE OF SECTION PROPERTIES

WEB	DEPTH	I	OFLANG	T1	T2	S
0.375	9.500	173.4#	21.000	0.375	0.375	35.78

FLOOR SPAN TABLE (FEET)

LIVE LOAD = 55 PSF LIVING QUARTERS DEAD LOAD = 15 PSF

DESIGNATION	SIZE	SPECIES & GRADE OF CHORDS	OVERALL DEPTH INCHES	SPACING (INCHES) 24.00	19.20	16.00	12.00
ULC9.	2X4	SPR NO.1	9.500	11'-10"	13'- 3"	14'- 6"	16'- 5"

SPAN FILE

SPACING 1	SPACING 2	SPACING 3	SPACING 4
142.278	159.071	174.254	201.211
159.687	194.858	230.030	300.373
626.170	777.963	929.755	1233.341
159.729	172.454	183.557	202.473
164.689	174.349	182.644	196.513

FIGURE 1.

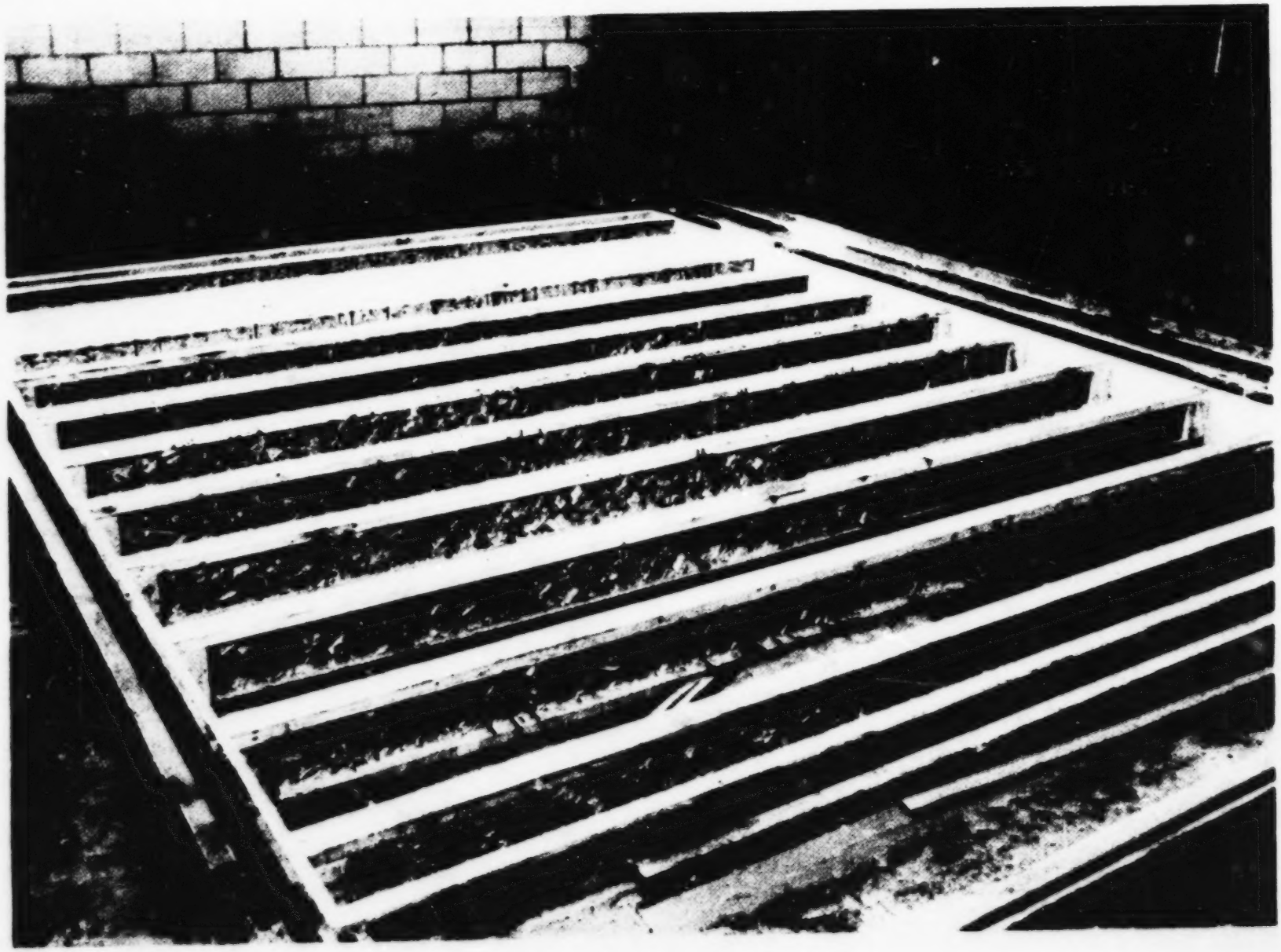


FIGURE 2. UNEXPOSED SURFACE DURING CONSTRUCTION

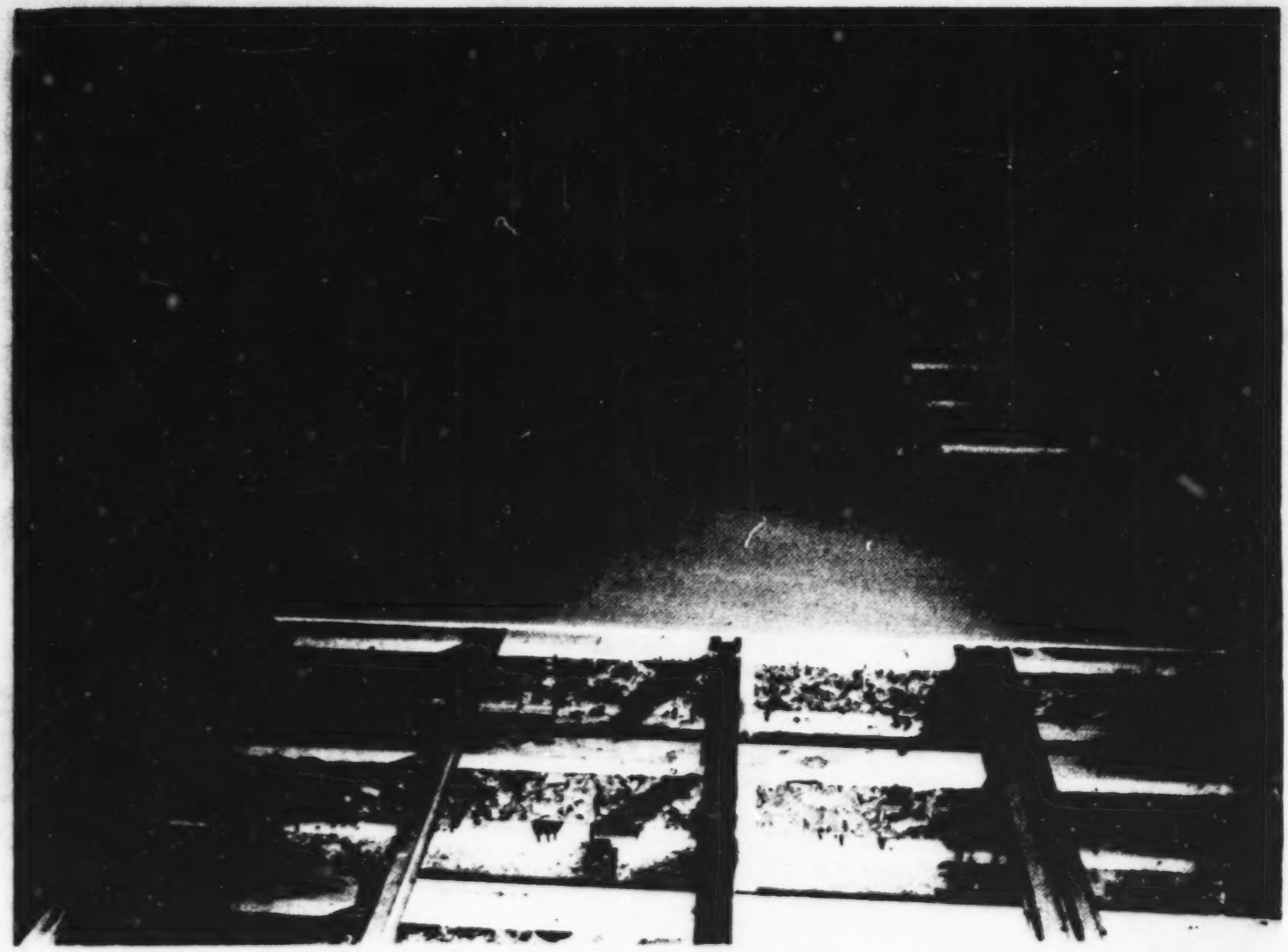


FIGURE 3. EXPOSED SURFACE DURING CONSTRUCTION

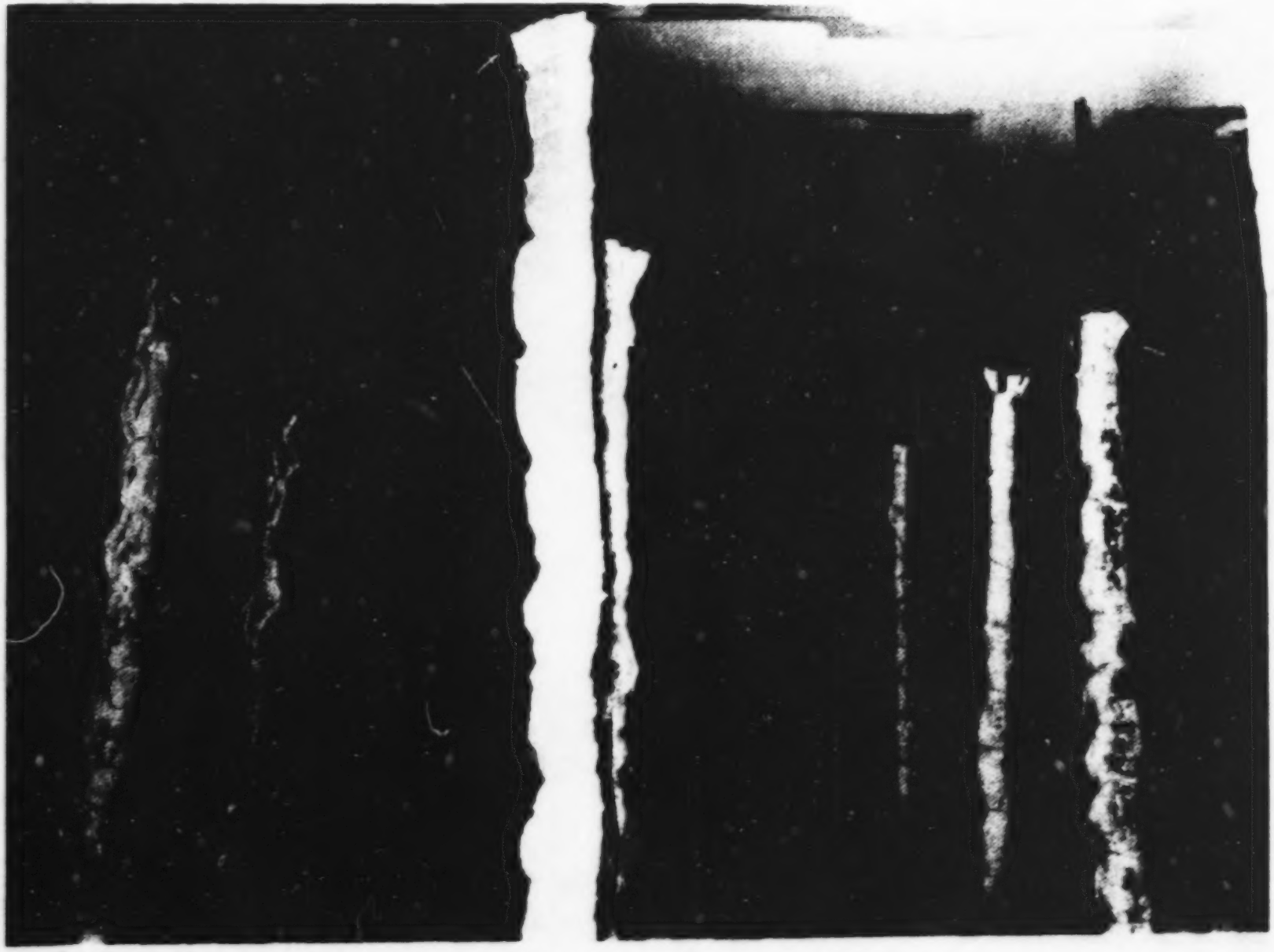


FIGURE 4. EXPOSED SURFACE BEFORE FIRE ENDURANCE TEST

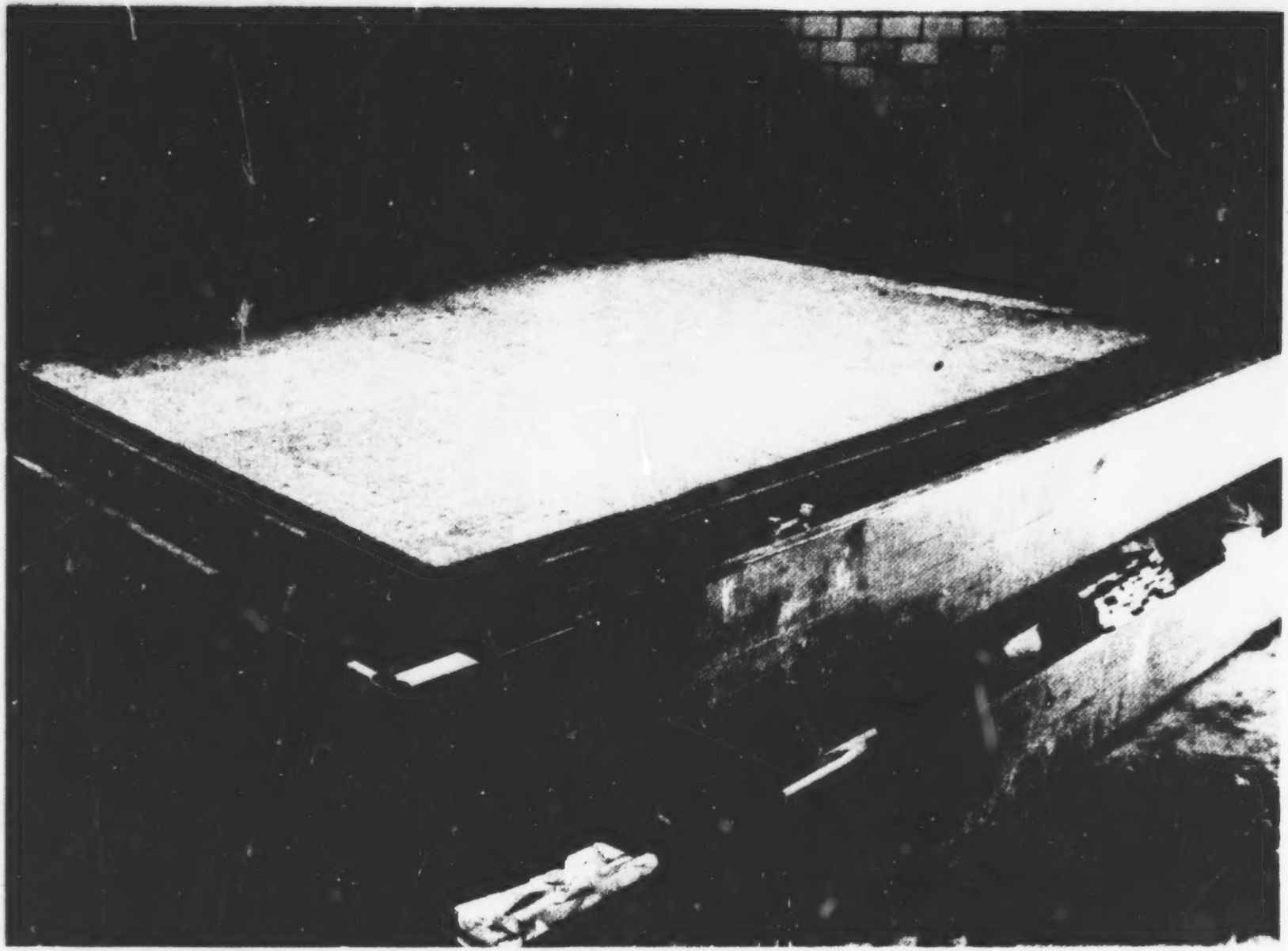
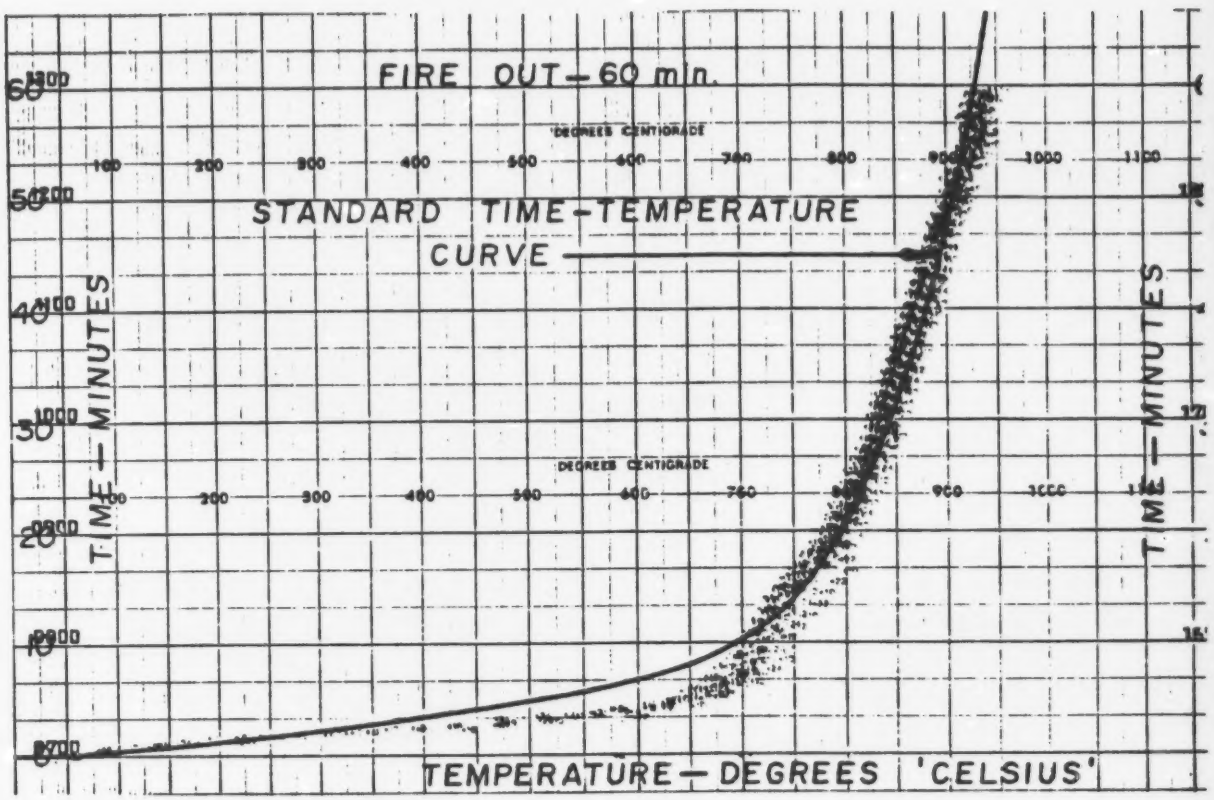
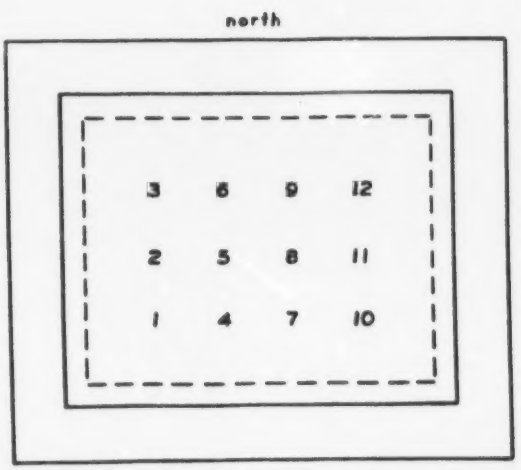


FIGURE 5. UNEXPOSED SURFACE BEFORE FIRE ENDURANCE TEST

FURNACE TEMPERATURES
CR1238
AUGUST 28 1984
UNDERWRITERS' LABORATORIES OF CANADA

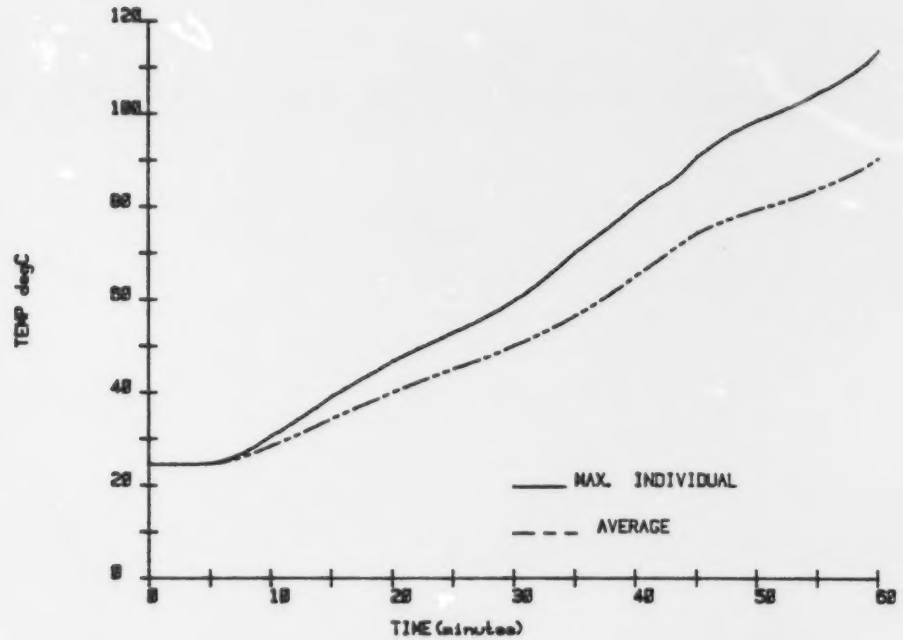


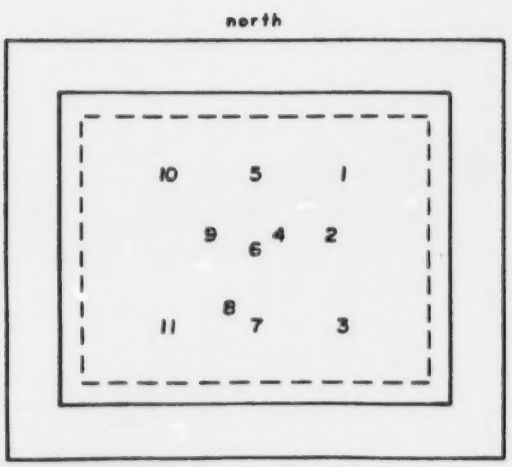


THERMOCOUPLE LOCATIONS

FIGURE 6.

UNEXPOSED SURFACE TEMPERATURES
CR1238
AUGUST 28 1984
UNDERWRITERS' LABORATORIES OF CANADA

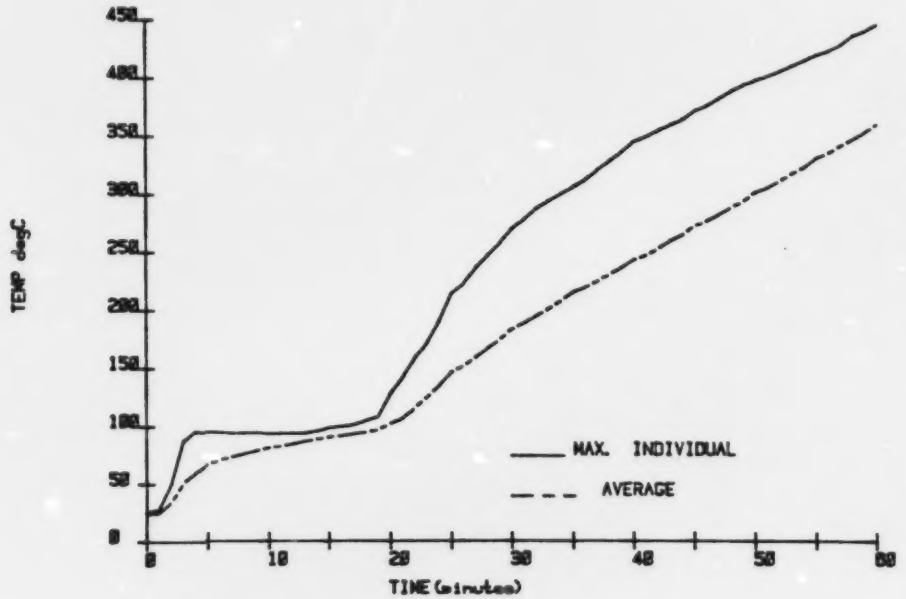


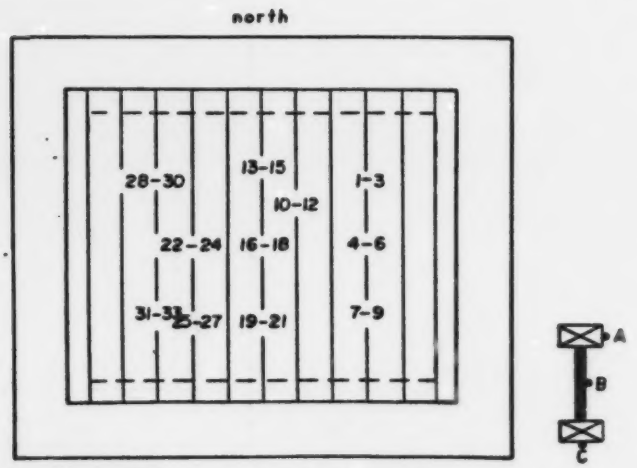


THERMOCOUPLE LOCATIONS

FIGURE 7.

BEAM TEMPERATURES
CR1238
AUGUST 28 1984
UNDERWRITERS' LABORATORIES OF CANADA

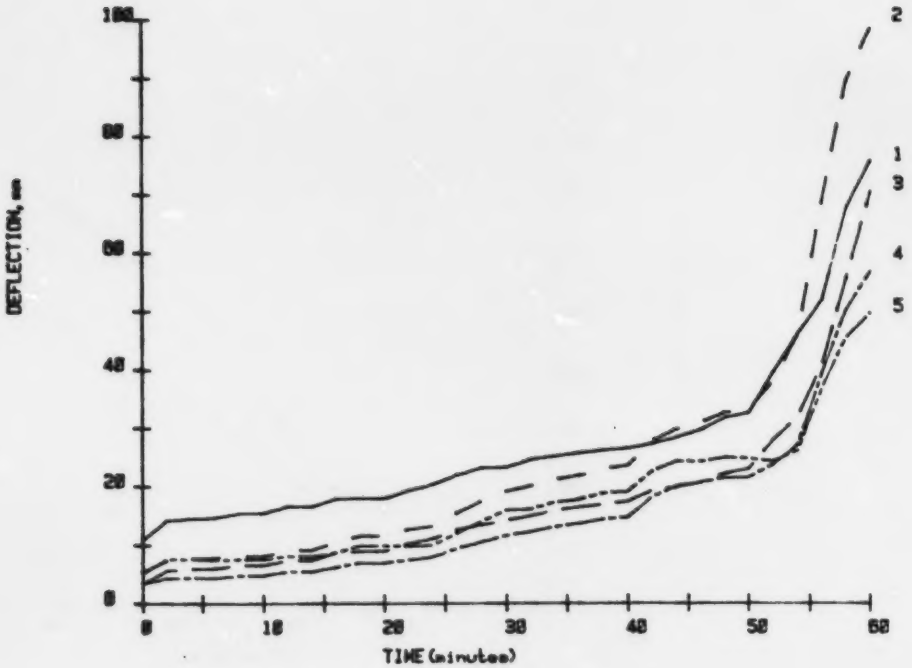


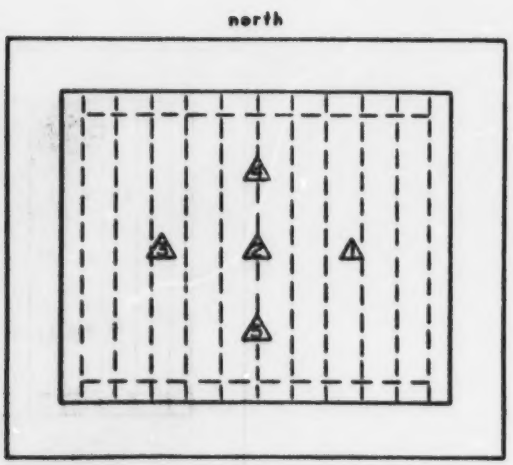


THERMOCOUPLE LOCATIONS

FIGURE 8.

DEFLECTIONS
CR123B
AUGUST 28 1984
UNDERWRITERS' LABORATORIES OF CANADA





DEFLECTION LOCATIONS

FIGURE 9.

FIGURE 10. EXPOSED SURFACE AFTER FIRE ENDURANCE TEST

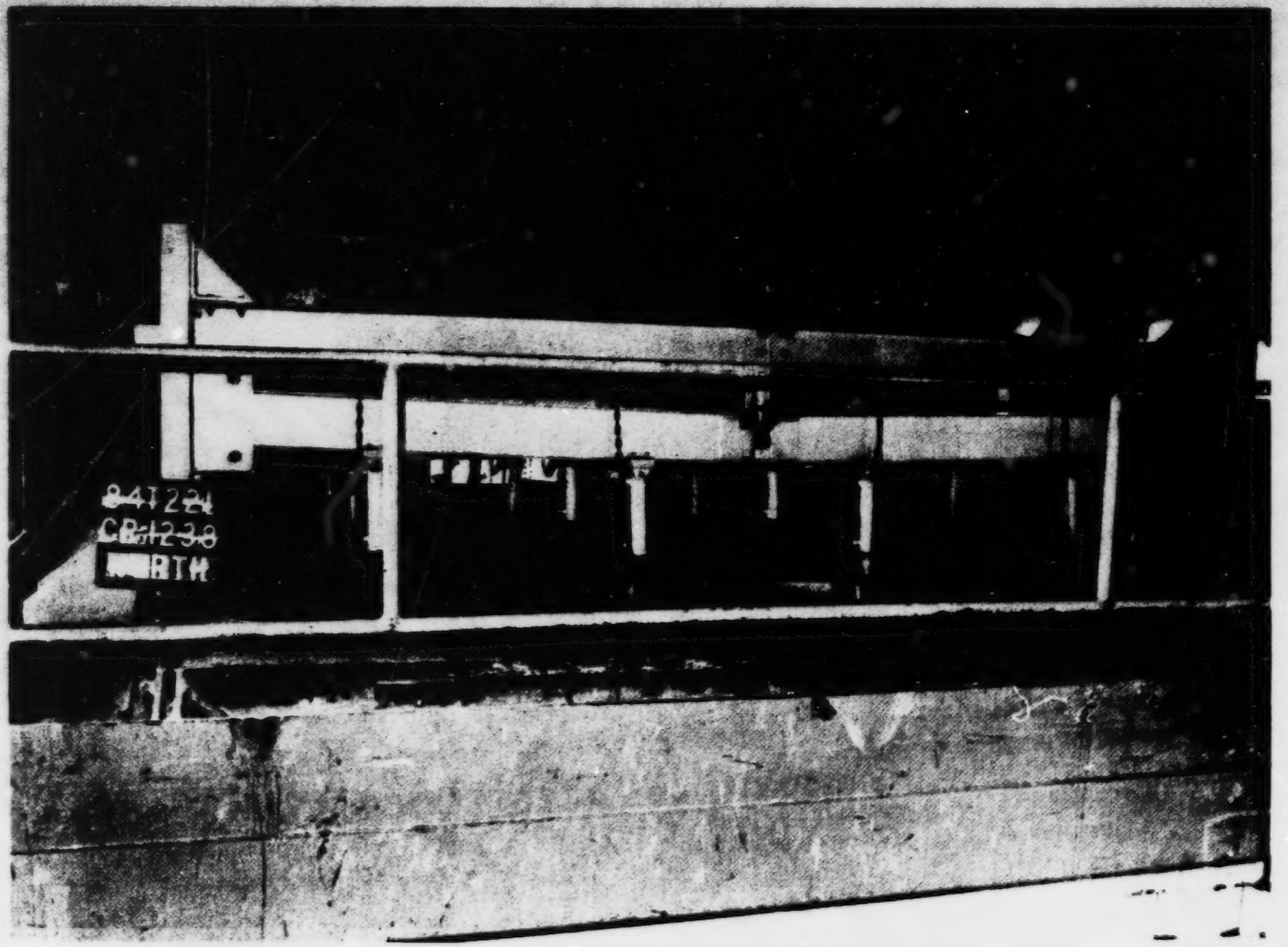
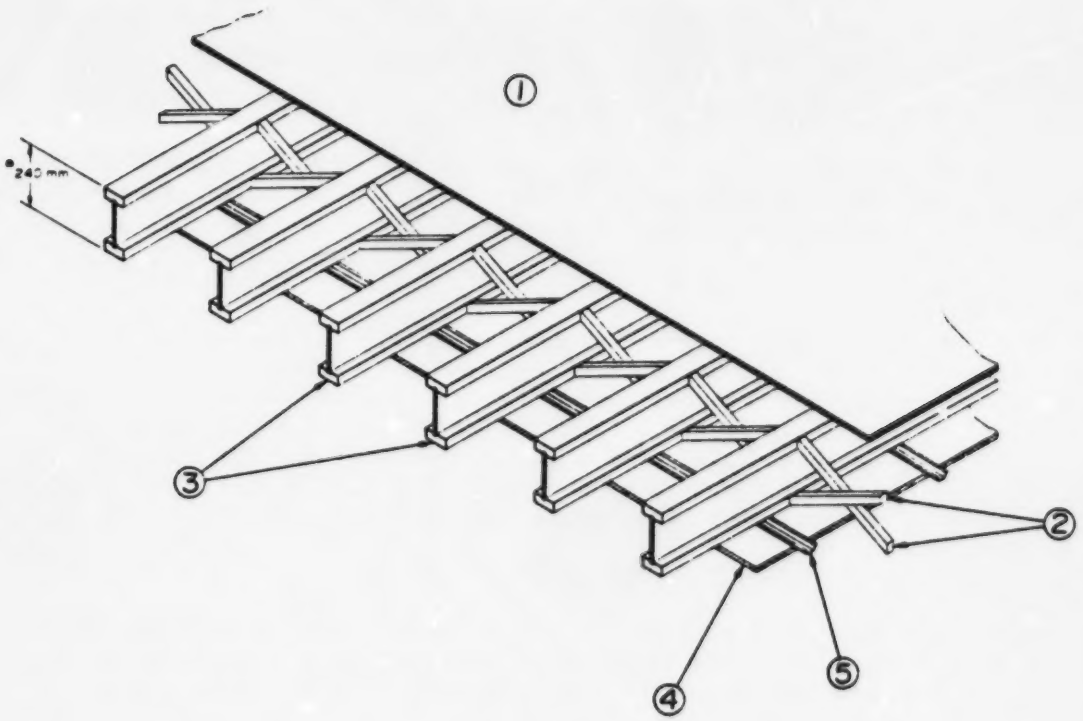


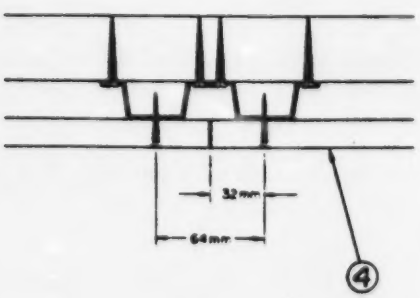
FIGURE 11. UNEXPOSED SURFACE AFTER FIRE ENDURANCE TEST

DESIGN No. M 508

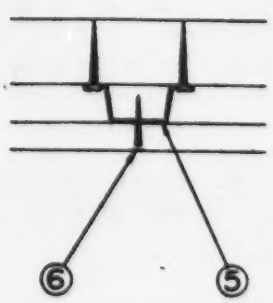
UNRESTRAINED ASSEMBLY RATING — 1 h

*Minimum Size





DETAIL 'A'



DETAIL 'B'

COMBUSTIBLE CONSTRUCTION

(Finish Rating — 24 min)

DESIGN NO. M508

Unrestrained Assembly Rating - 1 h

Combustible Construction
(Finish Rating - 24 Min)

1. Sub-Flooring - 15.9 mm thick by 1219 mm wide T & G boards laid perpendicular to beams with staggered end joints butted over beams. Unsanded sheathing grade phenolic bonded spruce or Douglas-Fir plywood or exterior grade waferboard.

2. Bridging - Nominal 50 by 50 mm spruce cross bridging.

*3. Structural Components - (Guide No. 40 U18.20C), Prefabricated beams of parallel structural wood top and bottom chords and waferboard webs, designated as Type "Wood-I".

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*4. Gypsum Wallboard - (Guide No. 40 U18.23) 15.9 mm thick by 1200 mm wide. Secured to resilient channels with 32 mm long Type "S" wallboard screws spaced 300 mm OC. Long edges of boards perpendicular to channels and located between joists. Butted end joints of wallboard staggered at least 600 mm OC and fastened at additional furring channels as shown in end joint detail. All screws located 38 mm from edges of boards.

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5. Resilient Furring Channels - Formed of 0.60 mm galvanized steel, spaced 600 mm OC perpendicular to joists. Fastened to each joist with 38 mm long self-tapping screws. Additional pieces 1800 mm long placed immediately adjacent to channels for attachment of end joints, fastened to each joist with 38 mm long self-tapping screws. Ends to extend 300 mm beyond each side of end joint and screwed to next joist at each side.

6. Wallboard Screws - Type "S" self-drilling and self-tapping screws (32 and 42 mm long).

7. Joint System (not shown) - Paper tape embedded in cementitious compound over joints and exposed nail heads covered with compound with edges of compound feathered out.

8. Floor Topping (Optional) - Non-structural concrete floor topping may be used in addition to Item 1.

*Listed by Underwriters' Laboratories of Canada for use as a component within the appropriate design.

4.0 SUMMARY AND CONCLUSIONS

The tests and evaluations carried out on the TTS Wood "I" indicate the following:

a) Structurally the TTS Wood "I" meets or exceeds the requirements of applicable Canadian building standards.

b) Fire tests and evaluation established that the Wood "I" can be incorporated in floor or ceiling assemblies having a fire resistance rating of 1 hour.

c) The TTS Wood "I" floor and roof trusses meet C.M.H.C requirements and are permitted for use in construction financed or insured under the National Housing Act.